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PHYSICAL CHARACTERISTICS OF COMETS

1965 — 1970

S. K. Vsekhsvyatskiy and N. I. Il'chishina

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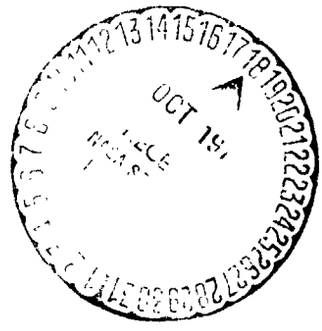

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16. Abstract

This book is the third supplement to the well-known *Cometography* of Professor S. K. Vsekhsvyatskiy (*Physical Characteristics of Comets*, Fizmatgiz, 1958). The two preceding supplements were published by Nauka Publishing House in 1966 and 1967. The present book contains, just as the first two, the orbital elements, descriptions, and information about observations of all comets which have appeared in 1965 — 1970. In all cases, detailed citations to the original sources are given. The book has a dictionary character to a significant extent.

It is intended for astronomy specialists and amateur astronomers who observe comets.

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PHYSICAL CHARACTERISTICS OF COMETS
1965 — 1970

S. K. Vsekhsvyatskiy and N. I. Il'chishina

Introduction

The present third supplement to S. K. Vsekhsvyatskiy's catalog of the absolute magnitude of comets [1 — 6] has been compiled on the basis of published photometric observations and brightness estimates, and it includes information about 66 apparitions of comets, during 1965 — 1970. Although the results of the absolute magnitude determination of comets in 1965 based on the first estimates were included in the second supplement [6], the data on these comets are given in the present compilation, since it appeared necessary to include all the observations published up to the present time. /3*

During the last six years, 66 apparitions of comets have been observed in all, of which 26 are new parabolic and long-period comets and 4 are new short-period comets. The apriori probability of the discovery of a new short-period comet is equal to approximately 0.17, i.e., it is a quantity of the same order of magnitude as in the preceding decades and 10^4 times larger than the theoretical recovery probability.

*Numbers in the margin indicate the pagination of the original foreign text.

The results are given in Table 1, which has been compiled according to the same principle of the preceding compilations. The numeration of the apparitions is given in the first column, and it follows the numeration of the general catalog, corresponding to the numeration of the cometary orbit catalog. The final and preliminary designations of the comet are given in the second column, as well as the name (in parentheses) for short-period and periodic comets. The names of the discoverers are given in the third column; columns 4 — 9 contain the comet orbital elements — T, q, P, i, Ω, ω, which are given with an accuracy to the second-third places after the decimal points. A dash in the sixth column corresponds to a parabolic orbit; the value of the eccentricity is given for hyperbolas. The names of the computers are given in the tenth column, and λ_p and β_p, the ecliptic coordinates of the direction to the orbit perihelion, are given in the eleventh and twelfth columns. The photometric parameters y and H_y, which are determined from the systems of equations of the form

$$H_y+y\lg r=m-5\lg\Delta,$$

if there is a sufficient number of observations and σlgr > 0.3, are given in the thirteenth and fourteenth columns. The absolute magnitude

$$H_{10}=m-10\lg r-5\lg\Delta;$$

is given in the fifteenth column; here r and Δ are the heliocentric and geocentric distances of the comet at the time of observation, and m is an estimate of the comet brightness (in stellar magnitude); the second value indicates variations in the comet brightness. The sixteenth column contains the reduced values of the maximum diameter of the head $D_1 = \Delta D$ in minutes of arc. The reduced maximum tail length

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FOLDOUT FRAME 1

TABLE 1*

COMETS 1965 — 197(

Comet No.	Comet	Discoverer	T	q	P	i	Ω	ω	Comput
871	1965 I—1965b Tsuchinshan 1	Astronomers of the Purple Mountain Observatory	Jan. 28,634	1,486	6,617	10°,53	96°,24	2[illegible],63	Sitarskiy
872	1965 II—1965 c Tsuchinshan 2	Same	Feb. 9,259	1,769	6,795	6,73	287,71	2[illegible]2,99	Sitarskiy
873	1965 III—1964 g (Wolf-Harrington)	Roemer	Feb. 15,359	1,614	6,535	18,46	254,22	1[illegible]7,02	Lea, Milbo
874	1965 IV—1965 i (Tempel-Tuttle)	Schubart	Apr. 30,004	0,982	32,9	162,71	234,44	17[illegible]2,58	Schubart
875	1965 V—1965 a (Reinmuth 1)	Tomita	Aug. 7,997	1,983	7,60	8,30	121,15	9[illegible]2,32	Wilson, Eg
876	1965 VI—1965 j (Klemola)	Klemola	Aug. 18,403	1,764	11,0	10,61	181,99	14[illegible]8 07	Marsden, A
877	1965 VII—1965 e (DeViso-Swift)	Klemola	Aug. 23,271	1,624	6,309	3,61	24,42	324,37	Marsden
878	1965 VIII—1965 f	Ikeya, Seki	Oct. 21,184	0,00779	880	141,86	346,30	69,05	Marsden
879	1965 IX—1965 h	Alcock	Oct. 26,04	1,298	—	65,12	174,71	150,27	Sekanina
880	1966 I—1965 g (Giacobini-Zinner)	Roemer, Lloyd	Mar. 28,3	0,934	6,408	30,94	195,97	172,92	Dinwoodie Freeman
881	1966 II—1966 c	Barbon	Apr. 17,78	2,019	34000	28,71	166,99	136,16	Sitarskiy
882	1966 III—1965 d (Van Biesbroeck)	Tomita	Jul. 17,6	2,409	12,407	6,60	148,84	134,23	Marsden
883	1966 IV—1966 d	Ikeya-Everhart	Aug. 5,199	0,880	e=0,994116	48,31	106,98	49,80	Sitarskiy Cholkovsk
884	1966 V—1966 b	Kilston	Oct. 28,081	2,385	162 000	40,27	155,36	154,48	Sitarskiy
885	1966 VI—1966 a (Neujmin 1)	Andrews	Dec. 9,40	1,543	17,93	15,03	347,18	346,81	Raudsaar
886	1967 I—1966 f (Grigg-Skjellerup)	Rudnitskiy	Jan. 18,462	1,003	5,121	21,05	212,69	359,17[illegible]	Sitarskiy
887	1967 II—1966 e	Rudnitskiy	Jan. 20,892	0,420	—	9,07	75,07	79,71	Marsden
888	1967 III—1967 c	Wild	Mar. 2,381	1,327	—	99,21	306,16	173,13	Castle
889	1967 IV—1967 b	Seki	Mar. 13,751	0,462	—	106,04	199,26	143,55	Castle
890	1967 V—1967 a (Tuttle)	Tomita	Mar. 31,3	1,023	13,76	54,39	269,79	206,92	Abalakin.
891	1967 VI—1967 e (Arend)	Tomita	Jun. 13,71	1,822	7,76	21,66	357,53	44,69	Hasegawa
892	1967 VII—1967 f	Mitchell, Janes, Gerber	Jun. 16,801	1,1774	—	56,74	31,61	78,78	Sekanina
893	1967 VIII—1967 m (Borelly)	Tomita	Jul. 17,6	1,45	7,00	31,12	76,14	351,03	Hasegawa
894	1967 IX—1967 g (Finley)	Tomita	Jul. 28,16	1,080	6,902	3,64	42,00	321,69	Marsden,
895	1967 X—1967 d (Tempel 2)	Tomita	Aug. 14,249	1,366	5,264	12,47	119,27	190,98	Aksnes, M
896	1967 XI—1967 e (Reinmuth 2)	Tomita	Aug. 18,241	1,942	6,735	6,98	296,10	45,34	Rabe
897	1967 XII—1967 i (Wolf-Kamenskiy)	Tomita	Aug. 30,206	2,506	8,429	27,31	203,80	161,25	Egerton
898	1967 XIII—1967 h (Encke)	Chernykh	Sep. 22,1	0,3382	3,299	11,99	334,24	185,91	Makover,
899	1967 XIV—1967 k (Wirtanen)	Tomita	Dec. 15,7	1,612	6,653	13,40	86,43	343,61	Julian
900	1968 I—1967 n	Ikeya, Seki	Feb. 25,717	1,607	e=1,004667	129,31	254,63	70,88	Marsden
901	1968 II—1967 i Schwassmann-Wachmann 2	Tomita	Mar. 14,272	2,147	6,516	3,73	125,99	357,66	Marsden,
902	1968 III—1968 f	Wild	Mar. 31,252	2,609	—	135,17	208,50	101,69	Marsden
903	1968 IV—1968 a	Tago, Honda, Yamamoto	May 16,204	0,680	—	102,20	232,44	50,36	Marsden
904	1968 V—1968 b	Whitaker, Thomas	Jun. 4,503	1,234	—	61,77	254,01	253,98	Marsden
905	1968 VI—1968 c	Honda	Aug. 7,908	1,1604	—	143,24	106,04	88,70	Marsden

FOLDOUT FRAME 2

TABLE 1*

COMETS 1965 — 1970

P	i	Ω	ω	Computer	λ_p	β_p	v	H_v	H_{10}	D_1	S (a.u.)	Comet
5,617	10°,53	96°,24	22.63	Sitarskiy	118°,5	+4°,0			14m,3	0',2—0',3		1965 I
5,795	6,73	287,71	202.99	Sitarskiy	130,8	—2,5			12,1		0,00001	1965 II
5,535	18,46	254,22	187.02	Lea, Milbourn	80,8	—2,2			12,1	0,5	0,00005	1965 III
32,9	162,71	234,44	172.58	Schubart	61,2	+2,2			13,6			1965 IV
7,60	8,30	121,15	9.32	Wilson, Egerton	131,2	+1,6			12,1			1965 V
11,0	10,61	181,99	148.07	Marsden, Aksnes	330,6	+5,2			13,4	0,2		1965 VI
5,309	3,61	24,42	324.37	Marsden	350,9	—2,0			14,4	0,3	0,0005	1965 VII
880	141,86	346,30	69.05	Marsden	275,7	+35,2	9,5	6,2	6,2	4,2—1,6	1,39	1965 VIII
—	65,12	174,71	150.27	Sekanina	341,2	+15,4			9,1	0,7		1965 IX
6,408	30,94	195,97	172.92	Dinwoodie, Freeman	12,0	+3,7			11,9			1966 I
34000	28,71	166,99	136.16	Sitarskiy	306,6	+18,9			5,52	5,9	0,33	1966 II
12,407	6,60	148,84	134.23	Marsden	283,4	+4,7			10,1	0,7		1966 III
0,994116	48,31	106,98	49.80	Sitarskiy, Cholkovskiy	131,0	+34,8			7,5	7,0	0,003	1966 IV
162 000	40,27	155,36	154.48	Sitarskiy	314,4	+16,2	17,0	1,9	4,5	5,0—7,5	0,095	1966 V
17,93	15,03	347,18	346.81	Raudsaar	331,4	—3,4			11,0	0,4		1966 VI
5,121	21,05	212,69	359.170	Sitarskiy	212	—0,3			14,8			1967 I
—	9,07	75,07	79.71	Marsden	125,4	+9,0	12,0	9,6	9,7—10,7	2,1	0,015	1967 II
—	99,21	306,16	173.13	Castle	121,1	+9,0			10,3	2,8	0,001	1967 III
—	106,04	199,26	143.55	Castle	31,2	+34,1			10,5	2,0	0,001	1967 IV
13,76	54,39	269,79	206.92	Abalakin, Belyaev	106,2	—21,5			10,0	2,2		1967 V
7,76	21,66	357,53	44.69	Hasegawa	41,2	+15,0			13,3			1967 VI
—	56,74	31,61	78.78	Sekanina	103,0	+55,1			5,1	13,4	0,11	1967 VII
7,00	31,12	76,14	351.03	Hasegawa	68,4	—4,7			12,5			1967 VIII
6,902	3,64	42,00	321.69	Marsden, Aksnes	3,3	—2,3			12,5			1967 IX
5,264	12,47	119,27	190.98	Aksnes, Marsden	310,0	—2,4			10,4	2,0	0,0005	1967 X
6,735	6,98	296,10	45.34	Rabe	348,6	+5,0			11,7	0,8		1967 XI
8,429	27,31	203,80	161.25	Egerton	7,0	+8,5			12,6			1967 XII
3,299	11,99	334,24	185.91	Makover, Castle	160,4	—1,1			11,4	1,3		1967 XIII
6,653	13,40	86,43	343.61	Julian	70,3	—2,6			14,3	0,1		1967 XIV
1,004667	129,31	254,63	70.88	Marsden	215,1	+47,0	14,7	3,1	4,36	9,5	0,045	1968 I
6,516	3,73	125,99	357.66	Marsden, Aksnes	123,8	—0,2			10,1	1,0		1968 II
—	135,17	208,50	101.69	Marsden	101,3	+43,5			7,5	1,0	0,004	1968 III
—	102,20	232,44	50.36	Marsden	218,2	+48,9	13,9	11,3	10,0—11,0	2,8	0,002	1968 IV
—	61,77	254,01	253.98	Marsden	170,7	—58			10,3	1,8		1968 V
—	43,24	106,04	88.70	Marsden	29,7	+37	9,95	5,8	5,5	6,0—6,9	0,041	1968 VI

(continued)

FOLDOUT FRAME 1

TABLE 1*

(concluded)

Comet No.	Comet	Discoverer	T	q	P	i	Ω	ω	Com
906	1968 VII—1968 d	Bally, Clayton	Aug.20,916	1,7715	—	93,17	38,69	26,92	Marsden
907	1968 VIII—1968 h (Perrine-Mrkos)	Mile	Nov. 2,270	1,272	6,722	17,76	240,16	166,07	Sitarsk
908	1968 IX—1968 e	Honda	Nov. 3,838	1,099	—	127,91	252,60	282,82	Marsden
909	1969 I—1968 j	Thomas	Jan. 12,160	3,316	18000	45,22	15,42	82,56	Marsden
910	1969 II—1970 p (Gunn)	Gunn	Apr, 19 00	2,443	6,80	10°,39	68,05	197,20	Marsden
911	1969 III—1968 i (Harrington- Abell)	Roemer	May 10,82	1,773	7,20	16,84	145,89	338,08	Marsden
912	1969 IV—1969 h (Churyumov-Gerasimenko)	Churyumov, сименко Gerasimenko	Sep. 11,03	2,2848	6,55	7,14	50,35	11,19	Marsden
913	1969 V—1969 l (Honda-Mrkos-Paydushakova)	Mrkos	Sep. 23,00	0,559	5,218	13,17	233,11	184,17	Marsden
914	1969 VI—1969 a (Faye)	Roemer	Oct.7,67	1,616	7,40	9,09	199,12	203,56	Khanina
915	1969 VII—1969 d	Fujikawa	Oct.12,44	0,774	—	8,93	191,66	299,03	Marsden
916	1969 VIII—1968 g (Comas-Sola)	Roemer	Oct.29,14	1,769	8,55	13,45	62,75	40,07	Aksnes
917	1969 IX—1969 g	Tago, Sato, Kosaka	Dec. 21,26	0,472	—	75,81	100,97	267,63	Marsden
918	1970 I—1970 a	Daido, Fujikawa	Feb. 15,81	0,0657	—	100,17	29,92	266,65	Marsden
919	1970 II—1969 i	Bennett	Mar. 20,046	0,5376	—	90,04	223,96	354,16	Marsden
920	1970 III—1969 b	Kohoutek	Mar. 21,67	1,722	—	86,26	311,10	123,39	Marsden
921	1970 IV—1970 h (Johnson)	Roemer, Elliott	Mar. 30,58	2,200	6,774	13,89	117,89	206,05	Vorob'
922	1970 V—1969 f (Slaughter-Burnham)	Roemer	Apr. 13,11	2,543	11,616	8,16	346,09	44,25	Sitar
923	1970 VI—1070 f	White, Ortiz, Bolelli	May 14,49	0,00888	—	139,07	336,32	61,29	Marsd
924	1970 VII—1970 d (D'Arrest	Roemer	May 18,44	1,1668	6,235	16,65	141,41	178,84	Marsd
925	1970 VIII—1970 b (Pons-Winnecke)	Roemer	Jul. 21,03	1,247	6,344	22,32	92,78	172,25	Marsd
926	1970 IX—1970 k (Jackson-Neujmin)	Kowal	Aug. 6,43	1,428	8,394	14,04	163,25	196,25	Marsd
927	1970 X—1970 m	Suzuki, Sato, Seki	Oct.1,798	0,4559	1,00037	60,76	292,96	318,55	Seki
928	1970 XI—1970 c (Kolpff)	Roemer	Oct.2,41	1,567	6,415	4,72	120,38	162,76	Sitar
929	1970 XII—1970 r (Kojima)	Kojima	Oct. 6,49	2,630	6,14	4,09	291,10	198,07	Marsd
930	1970 XIII—1970 i DuToit-Neujmin-Delporte)	Kowal	Oct. 8,16	1,677	6,306	2,861	187,89	115,69	Marsd
931	1970 XIV—1969 c (Whipple)	Pereyra	Oct. 9,41	2,480	7,47	10,24	188,39	189,82	Marsd
932	1970 XV—1970 g	Abe	Oct. 20,70	1,1125	—	126,71	21,00	86,58	Marsd Sorok

*Translator's note: Commas in numbers represent decimal points

FOLDOUT FRAME 2

TABLE 1*

(concluded)

i	Ω	ω	Computer	λ_p	β_p	ν	H_y	H_{10}	D_1	S (a.u.)	Comet
93,17	38,69	26,92	Marsden	317,2	+26,2	6,2	8,1	7,3—8,0	4,0	0,005	1968 VII
17,76	240,16	166,07	Sitarskiy	49,7	+4,3			15,6	0,9		1968 VIII
127,91	252,60	282,82	Marsden	256,4	—51,8			6,9	2,8	0,002	1968 IX
45,22	15,42	82,56	Marsden	94,9	+44,7			5,8	2,7—3,8	0,012	1969 I
10°,39	68,05	197,20	Marsden	258,2	—3,1	—	—	8m,0	1′	0,0005	1969 II
16,84	145,89	338,08	Marsden	124,9	—6,2	15	13,5	14,3	—	—	1969 III
7,14	50,35	11,19	Marsden	51,3	+1,4	—	—	10,4	1 3	0,004	1969 IV
13,17	233,11	184,17	Marsden	56,7	—0,9	—	—	11,6	1,0	—	1969 V
9,09	199,12	203,56	Khanina, Belyaev	42,4	—3,6	—	—	10,8	2,3	0,0063	1969 VI
8,93	191,66	299,03	Marsden	130,6	—1,4	—	—	8,3	5	0,032	1969 VII
13,45	62,75	40,07	Aksnes, Marsden	10,3	+8,6	15	12,0	10,7	1	0,003	1969 VIII
75,81	100,97	267,63	Marsden	2,9	—75,4	11	6,6	6,3	13	0,119	1969 IX
100,17	29,92	266,65	Marsden	132,2	—79,1	10	8,5	8,6	—	0,077	1970 I
90,04	223,96	354,16	Marsden	224,0	—5,8	11,5	4,3	4,2	4—11	0,39	1970 II
86,26	311,10	123,39	Marsden	118,6	+56,5	10	6,7	6,8	1,2	0,003	1970 III
13,89	117,89	206,05	Vorob'ev	323,3	—6,0	—	—	14,1	—	0,0001	1970 IV
8,16	346,09	44,25	Sitarskiy	30,4	+5,7	—	—	11,5	—	—	1970 V
139,07	336,32	61,29	Marsden	282,3	+35,1	10	5,6	5,7	6,7	0,58—0,88	1970 VI
16,65	141,41	178,84	Marsden	320,4	+0,3	—	—	9,5	1,6	—	1970 VII
22,32	92,78	172,25	Marsden	265,3	+3,2	15	13,0	14—15	—	—	1970 VIII
14,04	163,25	196,25	Marsden	0,0	—3,1	—	—	13m,4	0′,4—0′,8	0,0004	1970 IX
60,76	292,96	318,55	Seki	296,6	—35,2	15	8,5	8,9	5,4	0,02	1970 X
4,72	120,38	162,76	Sitarskiy	238,8	+1,5	—	—	10,5—11,5	—	—	1970 XI
4,09	291,10	198,07	Marsden	129,1	—1,3	—	—	10,6	2	0,0005	1970 XII
2,861	187,89	115,69	Marsden	303,2	+2,5	—	—	16,0	0,25	—	1970 XIII
10,24	188,39	189,82	Marsden	18,8	—1,9	—	—	10,6	—	—	1970 XIV
126,71	21,00	86,58	Marsden, Sorokina	278,5	+52,7	6,8	5,8	5,2	5—7	0,180	1970 XV

nal points

$$S=\frac{\Delta \sin C}{\sin (K-C)};$$

is given in the seventeenth column; C is the maximum observed tail length in angular measure, K is the phase angle,

$$\cos K=\frac{r^2+\Delta^2-R^2}{2r\Delta}$$

R is the distance from the Earth to the Sun.

It is necessary to note in particular the group of new short-period comets to which the two Chinese, 1965 I and 1965 II, the comet Kearns-Kwee 1963 VIII, and the comet Churyumov-Gerasimenko 1969 IV belong. S. K. Vsekhsvyatskiy indicated that the comets 1963 VIII, 1965 I, and 1965 II have a close agreement of the orbital elements T, i, e, q. These comets were found in a close encounter with Jupiter practically at the same identical period — about 1961, which coincides with the time of an immense outburst of activity on Jupiter; this event provided the basis for asserting the suggestion that comets are ejected from Jupiter's sphere of attraction as a result of volcanic processes on one of its satellites [6]. It is remarkable that the new short-period comet 1969 IV also has values for its orbital elements which are close to the elements of comets 1963 VIII, 1965 I, and 1965 II, and similar to these comets it was in a close encounter with Jupiter about 1961. The exit of four short-period comets from Jupiter's sphere of activity at one and the same period may be proof of their common origin from Jupiter's system as a result of powerful volcanic processes.

The curves of the variation of absolute magnitude of the comets which were observed in 1965 — 1970 are shown in Figure 1.

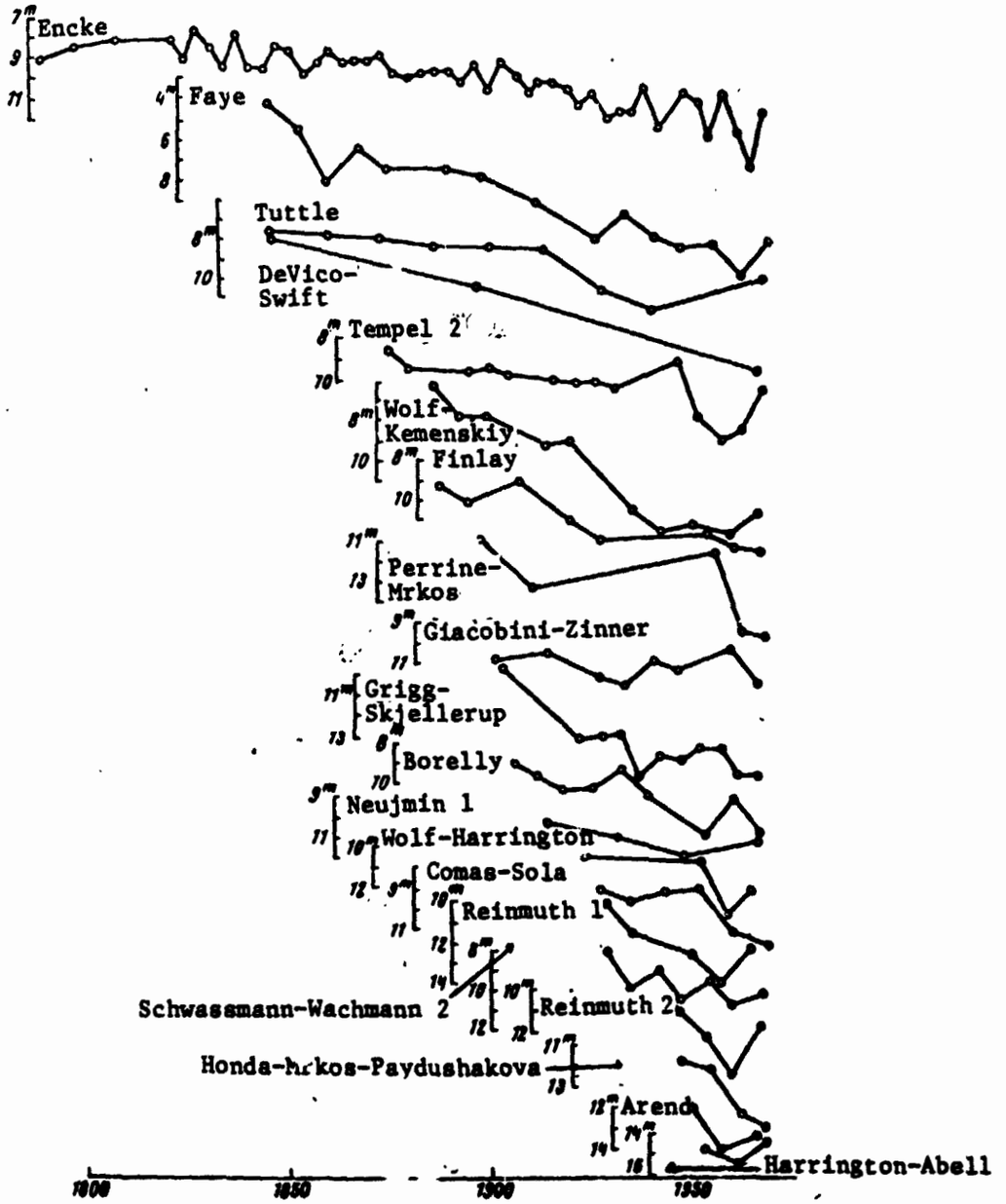

Figure 1. Curves showing the decline in the absolute brightness of short-period comets from apparition to apparition; the oscillations reflect variations in solar activity.

A comparison of the brightness variations of comets at different apparitions permits drawing the following conclusions:

1. Many comets undergo discontinuous changes in their absolute magnitude, and along with this, they exhibit a noticeable tendency to a secular brightness decrease established by S. K. Vsekhsvyatskiy. The comets DeVico-Swift, Finlay, Giacobini-Zinner, Borrelly, Comas-Sola, and Honda-Mrkos-Paydushakova prove to be weaker in comparison with the preceding apparitions.

2. Some comets which have appeared in 1967 — 1969 prove to be brighter or at least have not weakened in comparison with the preceding apparitions. A significant portion of these comets exhibited strong flare activity at their last apparition. The comets Harrington-Abell, Arend, Reinmuth 2, Schwassmann-Wachmann 2, Tempel 2, Faye, and Tuttle were brighter in comparison with the preceding apparitions. Similar deviations from the general /6 decline in brightness are associated with the high level of solar activity during the years of maximum and with the associated change of the conditions in interplanetary space.

The effect of a high level of solar activity in 1967 — 1968 can also be discerned in the fact that a large number of parabolic comets were discovered during these years (5 in 1967 and 7 in 1968).

More than nine bright comets were observed among the long-period and parabolic comets of 1965 — 1970: 1965 VIII, 1966 II, 1966 IV, 1966 V, 1967 VIII, 1968 I, 1968 VI, and others. One should pause in particular at the spectacular comet 1965 VIII Ikeya-Seki, which has one of the smallest perihelion distances. The comprehensive and exceedingly extensive observations and investigations of this comet yielded rich information about its

peculiarities and development. The investigations of its spectrum confirmed the presence of meteoritic masses in the nuclei of comets: the nature of the spectrum Comet 1965 VIII is analogous to the spectra of ordinary meteoric particles.

Comet Schwassmann-Wachmann 1 has, during the course of past decades, exhibited flare-ups of brightness, and along with this, a secular decline in brightness has become all the time more obvious. A decrease in absolute brightness by approximately 2^m is noted for Comet Oterma, which has not been observed since 1962.

The essential features of the comet observations are briefly cited in the next section. References to the literature are given in the descriptions in which the following abbreviations are used:

IC — International Astronomical Union Circulars. Circulars of the Astronomical Telegram Bureau of the International Astronomical Union. Cambridge, Massachusetts, U.S.A.

KTs — Cometary Circular of the Comet Investigation Group of the USSR Academy of Sciences. Kiev, University, Astronomy Department.

Astron. J. — Astronomical Journal. Yale University, New Haven, Connecticut, U.S.A.

ATs — Astronomical Circular of the Astronomical Communications Bureau of the USSR Academy of Sciences, Moscow.

AZh — Astronomicheskiy Zhurnal (Astronomical Journal), USSR Academy of Sciences. Moscow, 9/10 Kuznetskiy Bridge.

Astrophys. J. — Astrophysical Journal. University of Chicago, Chicago, U.S.A.

PASP — Publications of the Astronomical Society of the Pacific, San Francisco, U.S.A.

MN — Monthly Notices of the Royal Astronomical Society. London, England.

Quart. J. RAS — Quarterly Journal of the Royal Astronomical Society. London, England.

BAAH -- British Astronomical Association Handbook. London, England.

BAC — Bulletin of the Astronomical Institutes of Czechoslovakia. Prague, Czechoslovakia.

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DESCRIPTIONS OF THE COMETS

1965 I — 1965b /8

The new short-period comet Tsuchinshan 1. Discovered in China at the Purple Mountain Observatory (Nanking) on January 1, 1965. At discovery, its brightness was m = 15^m; the comet was found in the constellation Gemini at the position $\alpha = 6^h 44^m.8$, $\delta = +25°22'$. In January and February, it moved to the northeast and in March to the east. This was observed in China on January 5 and 7, then it was observed on Mount Palomar on February 9 with the 48-inch Schmidt camera (F. Veron); E. Roemer observed the comet in February, March, and April at Flagstaff. On February 23, the comet appeared as practically a stellar condensation of brightness $16^m.8$, surrounded by a faint coma 0'.3 in diameter; on March 2, it was a well-condensed image $17^m.4$ in brightness with a weak coma (30 minute exposure). The almost stellar central condensation weakened by April 1 to m = 18^m; the faint coma was 0'.3 in diameter. On April 24, it was well condensed, but clearly not a stellar image $19^m.0$ in brightness. According to Sitarskiy's calculations, the comet underwent a close encounter with Jupiter to a distance of 0.145 a.u. on December 12.96, 1960.

Literature. IC, No. 1895 — 1916; KTs, No. 22 — 28; Astron. J., Vol. 71, No. 1341, 1966, p. 449; PASP, No. 455 — 458; Acta Astron., Vol. 18, No. 1, 1968.

G. Sitarskiy's orbit was calculated on the basis of 18 positions in January — April, 1965 (Acta Astron., Vol. 18, No. 1, 1968). The absolute magnitude was $H_{10} = 14^m.3$, $D_1 = 0'.2$ — 0'.3 based on estimates of the Chinese astronomers and E. Roemer

(taking into account corrections of $1^m.5$).

r and Δ; Jan 1 — 1.52, 0.53; Feb. 19 — 1.51, 0.65; Mar. 11 — 1.55, 0.78; Mar 31 — 1.63, 0.96; Apr. 10 — 1.67, 1.06; Apr. 20 — 1.72, 1.18; Apr. 30 — 1.77, 1.30.

1965 II — 1965c

The new short-period comet Tsuchinshan 2, was also discovered in China at the Purple Mountain Observatory (Nanking) on January 11, 1965. At discovery, it was $m = 15^m$ with a tail <1°, and it was found at the position $\alpha = 8^h15^m$, $\delta = +17°31'$ in the constellation Cancer. From January till April, it moved southwest. It was observed in China on January 13; then E. Roemer observed it at Flagstaff in March — April. On March 10, the comet had the appearance of a stellar condensation $16^m.4$ in brightness with a fan-shaped tail up to 0'.4 directed towards the east; the comet appearance was almost unchanged when it was photographed on April 1. At Alma-Ata on March 9, it was observed with the /9 meniscus telescope (50/120 cm) as a diffuse object with $m = 14^m$ having a central condensation or nucleus and a tail <1° in length. It was photographed in March by Pfau with the help of the Schmidt telescope at the University observing station. According to the observations of E. Roemer, it was an almost stellar condensation on April 19, with $17^m.4$ at the apex of a fan-shaped tail (towards the southeast)0'.3 in length, and on May 31, it was an extreme condensation with 19^m.

Comet 1965 II had a close encounter with Jupiter at a distance of 0.458 a.u. on January 1.76, 1962. Both comets, 1965 I and 1965 II, have similar orbital elements, time of perihelion passage, inclination, eccentricity, semimajor axis, and with a

longitude of the ascending mode differing by almost exactly 180°. This fact permitted suggesting that both comets might be the results of a past splitting of one of Jupiter's comets.

Literature. IC, No. 1892 — 1916; KTs, No. 22 — 28; Astron. J., Vol. 71, No. 1341, 1966, p. 449; PASP, No. 455 — 458; Acta Astrophys., Vol. 18, No. 1, 1968.

G. Sitarskiy's orbit was computed on the basis of 16 of the most accurate positions in January — May (the mean error of a single observation was 0".55). The absolute magnitude is $H_{10} = 12^m.1$, S = 0.0001 a.u. from estimates of the Chinese astronomers and E. Roemer.

r and Δ: Jan. 11 — 1.74, 0.71; Feb. 19 — 1.76, 0.85; Mar. 11 — 1.78, 0.97; Mar. 31 — 1.82, 1.14; Apr. 20 — 1.87, 1.36; May 10 — 1.94, 1.59; May 30 — 2.01, 1.85.

1965 III — 1964g

The fourth observed apparition was of the short-period comet Wolf 2-Harrington (1924 IV, 1952 II, and 1958 V). Porter and I. Hasegawa assume it as established that the indicated apparitions and three passages (1932, 1939, and 1946) refer to a single comet.

E. Roemer (40-inch reflector, Flagstaff) recovered it on July 10, 1964, from the ephemeris of Lea and Milbourn. It was found at the position $\alpha = 0^h14^m.3$ and $\delta = 24°20'$; it is a practically stellar image $19^m.4$ in brightness on the plates. Probable weak images ($20 — 21^m$) were discussed after discovery of the comet on plates taken June 11, 14, and 15 with a long exposure. The correction to the ephemeris amounted to $\Delta T = +0^d.2$.

According to E. Roemer, it grew in brightness to $17^m.6$ towards the end of August. On the plates taken July 14, August 6, and August 30, the comet appeared to be almost a stellar condensation with weak traces of a coma or tail up to 0'.5 towards the southwest. On September 30 and October 27, it was significantly brighter and easily visible in the 40-inch reflector; the nucleus on these plates was h = $17^m.2$ and $16^m.5$, respectively; a small coma and tail extended as far as 0'.8 to the southeast. On November 8, Geyer and Schubart estimated m = 15^m using the Schmidt camera of the Astronomische Rechmen-Institut; on November 25, according to Roemer, the brightest of the comets observed at the end of 1964 had h = $16^m.2$, and there was an extreme nuclear condensation at the apex of the fan-shaped coma or tail directed towards the east /10 on December 26, h = $17^m.0$. In January of 1965, there were traces of a tail as far as 1'. In February, near perihelion (February 15.4) h = $15^m.6$, and there were traces of a tail as far as 0'.5 towards the southeast.

Literature. IC, No. 1871 — 1904; KTs, No. 21; RASP, No. 451 — 456; Astron. J., Vol. 71, No. 1341, 1966, p. 488 and 456; Quart. Journ. RAS, Vol. 6, No. 7, p. 205.

The orbit is that of G. Lea and S. Milbourn (IC, No. 1870).

We obtain H_{10} = $12^m.2 \pm 0^m.3$ and D_1 ~0'.5 from the cited estimates, taking into account E. Roemer's correction to the observations for the comet integral magnitude ($-1^m.5$ — $2^m.0$). The maximum tail length is S = 0.0005 a.u.

r and Δ: 1964, July 24 — 2.47, 2.04; Sept. 2 — 2.24, 1.45; Oct. 12 — 2.02, 1.09; Nov. 21 — 1.82, 1.03; Dec. 31 — 1.65, 1.19; 1965, Jan. 20 — 1.63, 1.31; Feb. 9 — 1.62, 1.45; Mar. 1 — 1.62, 1.61; Mar. 21 — 1.65, 1.78; Apr. 10 — 1.70, 1.96; and Apr. 30 — 2.16, 2.99.

1965 IV — 19651

Rediscovery of the short-period comet Tempel-Tuttle 1866 I — the precursor of the Leomid meteor shower. According to the investigators M. Candy and I. Schubart, Comet Tempel-Tuttle is identical with the comet observed in China in 1366 (October) and with the comet 1699 II, which was observed by Kirkh. After its discovery in 1866, the comet was not observed at its returns in 1899 and 1932. A weak diffuse image of the comet was discovered by I. Schubart of the Astronomische Rechmen-Institut on plates taken by Bester with the 10-inch astrograph of the Boyden Observatory (Bloemfontein, Africa) on June 30 and July 1, 1965. The comet photographic brightness was 16^m. On June 30, the comet was at the position $\alpha = 2^h38^m.8$, $\delta = +11°28'$ in the constellation Cetus, and towards the end of July, it was shifted towards the southwest. K. Goffmeister and Hunt did not detect the comet on the Sonnenbergh plates taken in May and June, and therefore, the comet must have been fainter than 14^m.

I. Schubart's rediscovery was confirmed upon the identification by Schubart and Geyer of an object at the edge of the plates taken on Mount Palomar with the 48-inch Schmidt telescope by Kearns and Wilson on June 30 and July 26. The comet positions agree with Schubart's orbit (IC, No. 1907) with $\Delta T = +5^d.0$.

Literature. IC, Nos. 1907, 1913, 1926, 1936, 1979; KTs, Nos. 31 and 33; PASP, Nos. 458 — 460; J. Porter, Suppl. B.A.A. Comet Catalogue, 1965; I. Hasegawa, Catalogue of Periodic Comets, 1968.

The comet absolute magnitude was $H_{10} \approx 13^m.6$.

r and Δ: June 19 — 1.31, 1.71; June 29 — 1.42, 1.55; July 9 — 1.53, 1.38; July 19 — 1.64, 1.22; July 29 — 1.75, 1.09.

1965 V — 1965a /11

The fifth observed return of the short-period comet Reinmuth 1 (1928 I, 1935 II, 1950 IV, 1958 II; the 1942 return was missed).

Discovered by K. Tomita on two plates taken January 6, 1965, with the 74-inch reflector of the astronomical station of the Tokyo Observatory at Okayama. It was found near the ephermeris position of Wilson, Freeman, and Bokli (BAAH, 1965) ($\alpha = 2^h22^m.1$, $\delta = +4°17'$). It was described as diffuse and of the 19^{th} magnitude without the central condensation.

It was observed by E. Roemer (Flagstaff) on January 24, and it appeared (at an exposure of 38 minutes in all) to be an unexpectedly faint object, an exactly starlike $18^m.2$. On January 26, it was also almost stellar on two exposures for 90 minutes, about $18^m.3$, and almost without a coma. On February 24, it appeared to be of the 19^{th} magnitude under very poor visibility. On March 4.13 and 4.19 — it is well condensed but a faint image of about $19^m.3$ with practically no coma.

Literature. IC, No. 1882; KTs, Nos. 21 and 22; PASP, Vol. 77, Nos. 454 — 456; Astron. J., Vol. 71, No. 1341, 1966, p. 449; Quart. Journ. RAS, Vol. 7, Nos. 3 — 4, p. 205.

The orbit is by P. Egerton (BAAH, 1965).

Introducing corrections (-1^m) to E. Roemer's estimates, we obtain from the indicated observations the following value for the absolute magnitude: $H_{10} = 12^m.1 \pm 0^m.3$.

r and Δ: January 10, 1965 — 2.60, 2.16; January 30 — 2.51, 2.33; February 19 — 2.42, 2.50; March 11 — 2.34, 264.

1965 VI — 1965j

Discovered by A. Klemola on five plates of the Yale-Columbia southern station (Argentina) taken with the 50-cm double astrograph on October 28 — November 2. The comet was located not far from λ Aquarii ($\alpha = 22^h54^m$, $\delta = -8°22'$) and was shifted towards the east. It appeared to be a faint hazy object of 17^m with a diameter of 0'.2 on the plates.

On the basis of these observations, B. Marsden calculated the first parabola and an ephermeris, but he advanced a suggestion as to a possible short-period orbit. The observations of A. Andrews and Noyelle at the Boyden Observatory on November 18 confirmed B. Marsden's suggestion, and according to the estimate $m = 17^m$. On November 21 and 22, K. Tomita photographed the comet with the 36-inch reflector of the Dodeira station and estimated $m = 17^m$. A. Klemola notes $m = 18^m$ on November 27.04, and at the last observation on October 13, the comet was at $18^m.5$.

Literature. IC, Nos. 1940 — 1948 and 2017; KTs, Nos. 33 and 36; Quart. Journ. RAS, Vol. 7, Nos. 3 — 4, 1966, p. 209; I. Hasegawa, Catalogue of Periodic Comets, 1968.

Assuming y = 2.5 and n = 15, Marsden found, from the first estimates, $H_0 = 11^m.5$; this corresponds to $H_{10} \approx 13^m.0$. From the cited estimates, $H_{10} = 13^m.4$ and $D_1 = 0'.2$ on the basis of Marsden's ephermeris. /12

r and Δ: 1965, October 7 — 1.78, 0.79; October 27 — 1.90, 1.16; November 26 — 2.09, 1.65; December 13 — 2.15, 1.82.

1965 VII — 1965e

The rediscovery of the short-period comet DeVico-Swift (1844 I and 1894 IV), which had not been observed for more than seventy years, was accomplished on the basis of the independent advance calculations of B. Marsden and I. Schubart. As a result of an integration from 1844, the comet passage through perihelion occurred twelve days early and closer to the truth. After the unsuccessful searches of E. Roemer in May and June of 1965, it was detected by A. Klemola with the 50-cm double astrograph of the Yale-Columbia southern station (El Moncito, Argentina) on June 30 at the position $\alpha = 23^h48^m.0$, $\delta = -6°35'$, and it was observed on July 2, 5, and 6. Traces of a coma 0'.25 in diameter and $m = 17^m$ were noticed on plates of the comet, but no traces of a tail were seen. On August 4, it was photographed with the 84-inch reflector of the Kitt Peak Observatory, and according to an estimate of VanBiesbroeck, $m = 16^m$. At this time, $\alpha = 0^h48^m.9$ and $\delta = -0°2'$.

On the very same night, E. Roemer obtained, with the 40-inch telescope of the Flagstaff station of the U. S. Naval Observatory (Arizona), during a 30-minute exposure, an almost stellar condensation of about $18^m.7$ with traces of a tail out to 0'.3 to the west-southwest. The comet had the same appearance on August 6. On August 25 — 30, the stellar nucleus was $18^m.0$, no coma was

visible, but traces of a tail stretched as far as 0'.4 to the west-southwest. On September 2, the steller nucleus was $18^m.6$, and traces of a tail as far as 0'.3 were noted with a 30-minute exposure; With a 1.5-hour exposure, the tail was visible as far as 1'.7 (west-southwest) and significantly twisted. On September 3, the comet was estimated to be 16^m at the Warner and Swasey Observatory with a Schmidt telescope, and on September 25, E. Roemer noticed a stellar condensation of $17^m.8$ at the apex of a fan-like tail with a length of 1'.2 (to the southwest). The last observation of E. Roemer on October 15 indicated a completely stellar nuclear condensation of about $18^m.0$ at the apex of a very faint tail (p = 240°).

Roemer's observation recorded significant variations taking place in the comet.

Literature. IC, Nos. 1911 — 1920; KTs, Nos. 28 and 29; Astron. J., Vol. 68, 1963, p. 795; Vol. 71, 1966, p. 457; Quart. Journ. RAS, Vol. 7, p. 207; S. Vsekhsvyatskiy [6], p. 66.

Orbits were computed by B. Marsden (Suppl. B.A.A. Catalogue, 1965) and I. Hasegawa (Catalogue of Periodic Comets, Kyoto, 1968). Also, see the orbits of I. Schubart (IC, No. 1911).

The absolute magnitude was derived on the basis of the cited estimates: E. Roemer's values, which refer to the comet nucleus, were reduced with a correction ($-2^m.0$) in agreement with the ideas expounded in the handbook "Photometriya Komet" (Comet Photometry) (Kiev, 1966). $H_{10} = 14^m.4 \pm 0^m.2$, $D_1 = 0.3$, and S = 0.0005 a.u.

At the 1844 I apparition, $H_{10} = 8^m.0$, and for 1894 IV — $H_{10} =$ /13 $10^m.2$ [1].

1965 VIII — 1965f

A new bright comet with a small perihelion distance (Figures 2 — 6). It was discovered independently by the Japanese amateur astronomers Kaoru Ikeya (Sidzuoka) and Tsutomo Seki (Tokyo) on September 18.8, 1965, as a diffuse object of 8^m with a central condensation at the position $\alpha = 8^h45^m.4$ and $\delta = -8°38'$ near α Hydrae.

Moving in the eastern direction, the comet passed through Hydra in September and the first ten days of October, and toward October 15, it crossed into Crater and passed through Corvus (about October 25) into the constellation Virgo. After perihelion passage (October 21.2), it moved from Virgo in the southwest direction through Corvus, Crater, Hydra, and Antlia.

From September 19 through 23, the comet was observed at the stations of the Smithsonian Astrophysical Observatory. A short tail, less than 0°.5, was noticed; from September 22 through 26, E. Roemer of Flagstaff noticed a sharply condensed nucleus, $h = 14 — 13^m$, and a narrow-rayed tail with a length of 30' (D = 3'). M. Antal, at the Skalnate Pleso Observatory, estimated on September 24 and 25 the comet brightness to be $m = 8^m$, and on September 26, according to a determination of K. Tomita (Tokyo), $m = 6^m$. From September 26, the comet was observed at Dushanbe and at the Krimean Astrophysical Observatory as a diffuse object with a tail less than 1°, and the comet brightness was estimated initially to be $7^m.5$, and then 6^m (September 28 — 29).

At the beginning of October, the comet was widely observed at the observatories in Byurakan, Krimea, Skalnate Pleso, Tokyo, Nice, Cordova, and other observatories. The comet integral brightness increased: on September 1 and 2, $m = 6^m.3$, on October

3 and 4, m = 5^m. On October 5 — 7, observers at Woomera (Australia) noticed a tail 7 — 8° in length. At this time, E. Roemer noticed a sharp nucleus in a circular envelope 0'.7 in diameter, a large coma, and a rayed tail. Along about October 11, the integral brightness increased to 3^m, by October 13 — to 2^m, and by October 15 — 16 — to 1^m; on October 17.8, at twilight m = 0, and on October 20 the comet was observed in the southwestern USA in the daytime with the unaided eye. On October 20.8, a tail with a length of 1°.5 was observed at the Organ Pass station; on October 21.0, E. Roemer at Flagstaff noticed a tail 2° in length and the appearance of a noticeable twisting in the tail; the integral brightness was estimated to be -10^m or -11^m. An explosion in the comet nucleus was observed and photographed on October 21.16, approximately 33 minutes prior to the comet passage through perihelion, at the Norikura coronal station of the Tokyo Astronomical Observatory. Subsequent observations confirm the disruption of the comet nucleus, which evidently took place repeatedly. Components of the last disruption (diffuse nucleus A and stellar nucleus B) were observed from November 4 until the end of December by G. Pon and E. Roemer at Flagstaff, by A. Andrews at the Boyden Observatory, by K. Ikeya and K. Tomita in Japan, and others. On the basis of the observations from November 12 through December 24, V. Sekanina calculated the preliminary elements of both nuclei, determined the most probable time of disruption of the primary nucleus (October 21.85), and estimated the scattering speed of the nuclei (15 — 25 meters/sec).

Near perihelion, the comet was widely observed at different /16
observatories with the help of photoelectric and spectral methods, radiotelescopes, and also some airplanes, ships, and rockets. On the afternoon of October 21, the comet was observed at the Krimean Astrophysical Observatory with the KG-1 coronograph for 2^h30^m after the comet passage through perihelion. At the Norikura Corona station of the Tokyo Observatory, a series of photographs

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Figure 2. Comet 1965 VIII Ikeya-Seki, November 1.026 UT. Tajik SSR Academy of Sciences Institute of Astrophysics, Jupiter 3, 6.5 minute exposure. Observer, E. V. Struk.

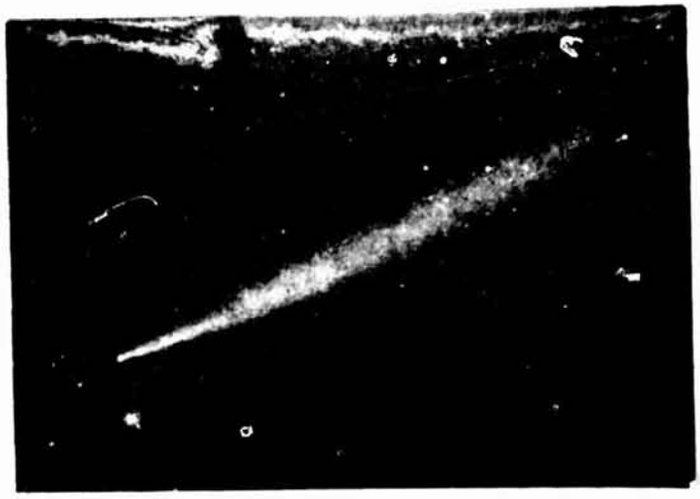

Figure 3. Comet 1965 VIII Ikeya-Seki, November 4,04 UT Jupiter 3, KAO (Krimean Astrophysical Observatory). Observer, V. N. Mo Mozhzherrin.

of the comet was obtained on October 21 with the help of a 12-cm coronograph, which subsequently showed the comet entrance into the Sun's atmosphere.

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Figure 4. Comet 1965 VIII Ikeya-Seki, November 5.96 UT.
Ussuriyskaya Solar Station, V. F. Chistyakov.

The integral brightness on October 22 (according to Antal's estimate) was equal to -4^m and rapidly decreased, so that on October 22.7, according to the estimate of W. Sinton and P. Boyce, was equal to 0^m. On October 21.6, the comet was observed with the unaided eye at Flagstaff and at the Organ Pass station. On October 24, a tail 5° in length was visible at the Moonwatch station at Pretoria. /17

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Figure 5. Comet 1965 VIII Ikeya-Seki, November 5.11 UT. 50-cm Schmidt camera, 12-minute exposure. E. E. Khachikyan.

On October 23 — 26, the comet was photographed from airplanes at an altitude of 13,000 meters above sea level. The successive photographs, studied by L. Khafni, M. Bader, and R. Innes, showed a rapid development of the tail. On October 23, the tail length at twilight was 2°, on October 24 — 5°1, on October 25 — 10°50', and on October 26 — 13°50'. On the October 24 and 25 photographs, twistings and peculiarities of the motion in the mean tail were detected and measured. A dark band was noticed in the middle of the tail.

Spectral observations near perihelion were carried out at many observatories. On October 20.4, a spectrum was obtained of the comet nucleus at the Radcliffe Observatory, which showed the presence of FeI emissions, and also the H and K lines of ionized Ca. At Sacramento Peak, a photoelectric record of the spectrum was made for the Na D line with a resolution of 2 Å/mm and with a high resolution 0.2 Å/mm, and atomic lines of FI and CA II as well as relatively weak molecular emissions were detected. On October 21.4, the H and K lines of CA II and the Na D lines superimposed on the continuum as well as emission bands, including Fe, were observed in a spectrum of the comet obtained by F. Dossin at the Aux Provence Observatory at a dispersion of 4 Å/mm. On October 21, when the comet was

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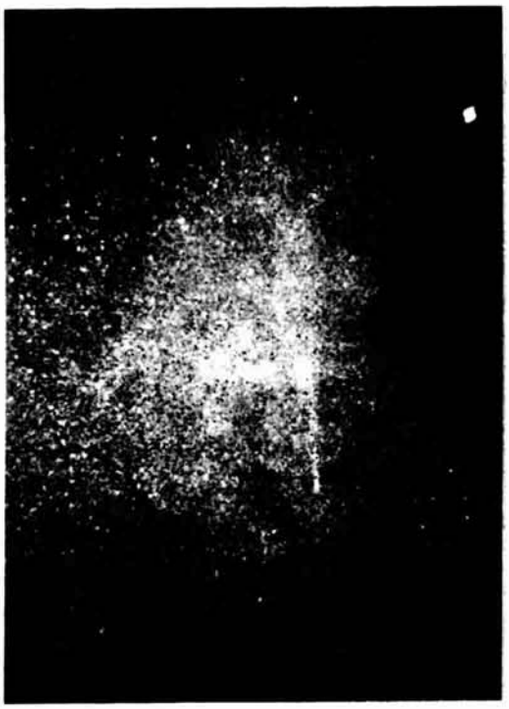

Figure 6. Comet 1965 VIII Ikeya-Seki, November 30.864 UT. Ussuriyskaya Solar Station. Observer, V. F. Chistyakav.

at the heliocentric distance of 0.05 a.u., spectrograms of the 4200 — 6100 Å region were obtained at the Lomnitskiy Shchit Observatory, and emission lines of Na (5889, 5895) and lines of Fe I and Cr I were identified.

At the Liks Observatory, Preston obtained spectrograms of the comet for six days during the period between October 8 and November 3, and he carried out a detailed analysis of these observations. On October 22, 1.6 days after perihelion, emission lines of O, Na I, Ca I, Mn I, Ni I, Cu I, and CN (Figure 7) were present in the comet spectrum. At the Lowell Observatory, Sinton and Boyce, on October 19 — 22, conducted photometric observations of the nucleus with the spectral scanning method. The analysis showed that the intensity of the Na D line was the highest on October 20.75 and decreased strongly to October 22, and the H and K lines of Ca II disappeared. Study of the D line of Na in the comet near perihelion was also carried out by K. Evans and G. McKim Malville by means of an analysis of slitless spectrograms obtained on October 20 between 21^h00^m and 22^h42^m UT at the Klaimax corona station with the help of an f/24 coronograph-spectrograph system. During the observations, the ratio of the intensity of the D_2 line to the intensity of the continuum decreased by approximately a factor of 5, and the ratio of the intensities I (D_2)/I (D_1) in the comet head

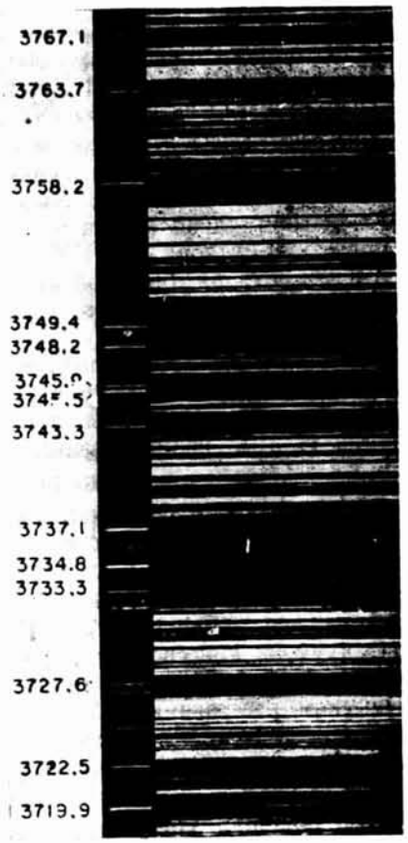

Figure 7. Emission spectrum of the central part of the head of Comet Ikeya-Seki 1965 VIII. Obtained with the 100 meter solar telescope of the Kitt Peak Observatory.

decreased stably in proportion to the comet nearness to the Sun. This ratio of intensities measured along the comet axis at various times was a minimum in the vicinity of the nucleus and decreased with time. /18

At Byurakan, on November 3, 4, and 5, electropolarometric measurements were carried out with the help of the AZT-14 20-inch telescope and three filters (λ_{eff} = 6300, 5400, and 4500 Å). The values found for the degree of polarization of the head radiation lie within the limits 6.7 — 10.5% and of the tail — 11 — 15%, and the degree of polarization increases with wavelength. Polarization measurements were also carried out at the Kodaikanal Observatory (India) by M. Vainu Bappu, K. Sivaraman, and others with the help of a Polaroid-equipped photoelectric photometer mounted on a 20-cm reflector on November 3.97, 4.97, 14.97, 15.95, 16.97, and 19.95. The degree of the radiation polarization was measured at λλ3883, 4310, 4740, and 5875, and lie within the limits 3.5 — 19.8%, and the angle of the plane of oscillation varied during the observations from 0° to 38°. The degree of the continuum polarization at a phase of 90° was equal to 24.7%, and in the tail it was 13.6% at a distance of 3' from the head.

Z. Tseplekha and Z. Val'nichek conducted photographic photometry of the comet near perihelion in the red spectral region with an equivalent focus of 16.5 meters. The comet stellar magnitudes on October 20, 21, and 22 were equal to $-2^m.6$, $-3^m.8$, and $-2^m.7$, respectively. Photoelectric measurements of the comet in the near infrared region (λ = 0.87 μ) carried out by V. Vanysek on October 20 with the help of a 65-cm reflector of the Andrejov Observatory gave a brightness in the visual region of $6^m.0$ and in the infrared region — $6^m.9$. Infrared observations of the comet were also carried out at the Mount Wilson observatory by E. Becklin and G. Westphal from October 6 until November 1. In the $\lambda\lambda$1.5 — 1.8, 2.0 — 2.4, 3.0 — 3.8, and 8.4 — 13.5 μ regions, the absolute intensities of the head and tail were measured at various distances of the comet and the Sun and the color temperatures were calculated. The ratio of the emission intensities /19
is obtained in the same way as for iron particles, and the color temperature of the head varied with distance from the Sun according to a law characteristic of a gray body.

On October 21 — 22, radio observations of the comet were carried out with the help of the 22-meter telescope of the USSR FIAN (Fizicheskiy institut Akademii nauk — P. N. Lededev Institute of Physics of the Academy of Sciences). The comet radiation was not detected, and observations of hard cosmic radiation (at Chernovtsiy) revealed its amplification by a factor of 7 during the time of the comet passage near the Sun.

After perihelion passage, the comet brightness rapidly weakened. However, one should bear in mind the difficulties in estimating the brightness in the daytime and twilight skies. On October 22.2, the integral brightness was estimated to be -4^m (Antal), on October 22.4 — $2^m.7$ (Val'nichek), and on October 22.7 — 0^m (Cinton, Boyce). On October 28, Z. Pereyra estimated the

comet brightness to be 2^m, and on the same day, I. R. Beytrishvili noticed a tail more than 6° in length. On October 29, the comet brightness was equal to 3^m (Pereyra), and a tail of more than 20° was photographed with an astrograph and Schmidt camera at Abastumani. A nonuniformity of the tail and a similarity to a twisted rope was noted. On November 1, according to the observations of K. D. Gul'medov (Ashkhabad), the comet brightness was 2^m, and there was a tail of 35° without nonuniformities. On November 2, K. Ibadinov and A. M. Bakharev noticed a tail of 30° and the comet brightness on this day, according to Antal's estimate, was $3^m.5$, and on November 3.2, it was m = 4^m. The tail length was 13°, and its maximum width was 2°. Visual and photographic observations of the comet were carried out at the Sonneberg (Goffmeister, Brandt, Yakish) on the mornings of November 2, 5, 6, and 7. The tail length reached 40°, and a break was observed in the tail at a distance of about 30° from the head.

According to K. Goffmeister's estimates, the speed of the break relative motion from the nucleus was approximately 1° per day. The length of the comet tail was, according to the observations of V. F. Chistyakov (far east station), 40° during the period October 31 — November 3, 36° on November 5, 32° on November 7, 25° on November 19, 28° on November 20, 20° on November 22, and 16° on November 24. According to observations at the Krimean Astrophysical Observatory on November 5, the comet head was melon-shaped with a sharp central condensation, with the head diameter being 2', the brightness was about 3 — 4^m, and there was a weakly twisted tail 25° in length and with a width at the head of 2' and at the middle part of about 1°. On November 11, the comet brightness was 6^m (according Pererya's observation), and on November 12, K. Tomita observed the two nucleii. The large and diffuse nucleus A was 6^m, and the stellar nucleus B was 11^m. On November 17, M. Antal estimated the comet brightness to be $6^m.5$,

and on November 21.8, according to K. Tomita's estimate, the brightness of the diffuse nucleus A was equal to 7^m and of the stellar nucleus B 11^m. The comet two nucleii were observed by B. Mile on November 24 and by V. Pererya on November 17, 19, and 27 and December 3.7 using the Cordoba Observatory astrograph and on December 24 with the help of the 60-inch telescope of the Basque-Alegre station. On December 3, the comet was observed at the Krimean Astrophysical Observatory as a diffuse spot with a central condensation, without a tail, and with a brightness of 8^m. On December 31, G. Tamman observed the comet with the 48-inch Schmidt telescope of the Mount Palomar Observatory, and he noticed a tail 1°.5 in length. On January 14, 1966, G. Tamman, using the 48-inch Schmidt telescope, photographed a tail of 1°.3 /20
The comet was recorded on plates of the Baker-Nunn camera of the Smithsonian Observatory station in New Mexico and in Hawaii on January 27 and 28 and February 12, 1966. On February 13, VanBiesbroeck did not detect the comet with the 84-inch reflector at Kitt Peak, but several days later, it was photographed by A. Klemola with the 20-inch astrograph of the Yale-Columbia southern station. Investigation of the tail was carried out by N. S. Chernykh [Izv. KAO Vol. 37, 1967, pp. 10 — 20; ibid., Vol. 38, 1968, pp. 245 — 251; Problemy kosmicheskoy fiziki (Problems of Space Physics) No. 3, 1968, pp. 47 — 56] and by Kh. Ibadinov [Dokl. AN TadzhSSR, Vol. 10, No. 4, 1967; Komety i meteory (Comets and Meteors), No. 16, 1968].

Absolute photometry and a discussion of the structure and shape of the comet tail was carried out by S. K. Vsekhsvyatskiy, A. A. Demenko, and V. T. Khrapach [Problemy kosmicheskoy fiziki (Problems of Space Sphysics), 1968, No. 3]. The interaction of the comet tail with the solar plasma near perihelion was investigated by R. Lust and G.-U. Schmidt (Mitt., 1968, No. 25) and by M. Belton and J. Brandt (C. r., Vol.266, No. 26, 1968). Study

of the photographs taken from a specially equipped high-altitude airplane from October 23 to 26 was carried out by L. Khafni, M. Rader, and R. Innes (Astron. J., Vol. 72, No. 9, 1967, p. 1166).

Literature. IC, Nos. 1921 — 1952; KTs, Nos. 29 — 37; Astron. J., Vol. 71, Nos. 1, 6, and 9, 1966; Vol. 72, No. 9; Astrophys. J., Vols. 145, 149, and 153; PASP, Nos. 460, 461, 463, and 469; Observatory, Vol. 86, Nos. 950 and 951; Sky and Telescope, Vol. 35, No. 5, 1968; BAC, Vol. 17, No. 4; C. r., Vol. 266, No. 26; Strolling Astronomer, Vol. 20, Nos. 9 and 10; Ciel et Terre, Vol. 81, Nos. 11 — 12, 1965; Astronomie, Vol. 81, 1967; in the collection: Aktivnye protsessy v kometakh (Active Processes in Comets), Kiev, 1966; in the collection: Voprosy kosmicheskoy fiziki (Problems of Space Physics), Nos. 3 and 4, Kiev, 1968 and 1969; in the collection: Astrometriya i astrofiziki (Astrometry and Astrophysics), No. 4, Kiev, 1969; Izv. KAO (Krimean Astrophysical Observatory), Vol. 37, 1967 and Vol. 38, 1970; Soobshch. Byurakanskoy obs. (Communications of the Byurakan Observatory), No. 38, 1968; in the collection: Nablyudeniya komet v SSSR (Observations of Comets in the USSR) (Naukova dumka, Kiev, 1970).

The orbit is by Z. Sekanina (IC, No. 1947). Preliminary values of H_{10} (with y = 10) were taken to be equal to $6^m.0$ (see [6], page 68). The absolute magnitude determined on the basis of the entire collection of observations is $H_{10} = 6^m.2 \pm 0^m.2$, and D_1 was 4'.2 in September and 1'.6 near perihelion. S = 1.390 a.u. (for November 2 — 3, the phase angle was K = 68°.7).

Calculations of the photometric parameters were carried out by I. Boushka on the basis of 51 observations prior to and after perihelion: y = 9.5, $H_y = 6^m.2$, $m_0 = 6^m.5$. K. Elliot derived n = 5.1 (y = 12.6) on the basis of 54 estimates. An analysis of 114

visual determinations of the comet integral brightness made by members of the ALPO was carried out by D. Milon, Solberg, and R. Minton; $H_y = 6^m.2$ and $n = 3.28$ ($y = 9.46$). For values of r and Δ, see KTs, 30, 31, 32, and 36.

1965 IX — 1965h

A new comet was discovered by the English amateur G. E. D. Alcock on September 26.88. The comet was observed in Hercules near M 13 at the following position: $\alpha = 16^h54^m.0$, $\delta = +35°02'$.

Upon discovery, it was a diffuse object of 10^m with a central condensation. /21 It moved southeast in Hercules, and during the last third of October, it crossed into Aquila and continued its southeastern motion. At the beginning of November, it crossed into the southern half of the sky and passed through Aquarius into Capricornus, and at the end of November, it became invisible.

After its discovery, G. Alcock observed the comet on September 27.8 (brightness equal to 10^m), M. Antal on 27.8 and 29.8, and Van Biesbroeck on September 28 and 30 (according to their estimates $m = 11^m$). On September 30 at Flagstaff E. Roemer estimated the brightness of the nucleus surrounded by a faint coma to be $16^m.5$. At the beginning of October, the comet was observed at Tartu, at Flagstaff, and at the Skalnate Pleso Observatory, Nice, Kiev, and Odessa. On October 1 — 3, according to Raudsaar's estimates, the comet brightness was $10 — 11^m$. According to E. Roemer, the nucleus was approximately $16^m.5$, surrounded by a rather bright coma 0'.6 in diameter, based on 5 — 15 minute exposures on October 1, 3, 15, and 23. In October, M. Beyer (Bergedorf), Mile (Nice), Shur and Geyer (Heidelberg), and Waterfield (Ascot) also observed the comet. In November, the comet was located low above the horizon for northern observers.

On November 12 and 13, it was observed by B. Mile and M. Beyer.

Literature. IC, Nos. 1923 — 2052; KTs, Nos. 30 — 38; PASP, Nos. 459 — 460; AN, Vol. 289, Hf. 4, Nos. 177 — 179; Astron. J., Vol. 71, 1966, p. 457; Quart. Journ. RAS, Vol. 7, Nos. IX — XII, 1966, p. 208.

The orbit is by B. Marsden (IC, No. 1939; KTs, No. 33); T = October 26.1402, 1965, q = 1.2939.

B. Marsden found, for the nucleus brightness during the first period, $H_{10} = 11^m.0$. The absolute magnitude on the basis of M. Beyer's observation and other estimates (33 observations in all) was $H_{10} = 9^m.15$; the brightness of the nucleus was $h_{10} = 14^m.8$ (from E. Roemer's observation), and $D_1 = 0'.7$. M. Beyer carried out an analysis of a large series of 23 observations (AN, Vol. 298, p. 4), made in the course of 60 days. He found $H_{10} = 9^m.08$. Brightness variations were noted during the observation period, which are unexpected in the case of a small variation in r and Δ, and there was a similarity of the variations in the coma diameter to the total brightness variation. A comparison was carried out of the brightness variations with solar activity.

r and Δ: September 26 — 1.38, 1.26; October 2 — 1.35, 1.19; October 17 — 1.30, 1.11; October 27 — 1.29, 1.11; November 6 — 1.30, 1.16; November 16 — 1.33, 1.25; and December 6 — 1.43, 1.52.

1966 I — 1965g

This was the eighth observed apparition of the short-period comet Giacobini-Vinner (1900 III, ..., 1959 VIII, one return in 1953 was missed). It was found by E. Roemer and O. Lloyd at

Flagstaff on September 17, 1965, on a plate taken with a 96-minute exposure. The comet had a stellar appearance, a brightness of $19^m.4$, and it was found at its discovery in Serpens at the position $\alpha = 15^h13^m.88$, $\delta = +3°14'.75$.

On E. Roemer's plates, the comet begins to look like a stellar object of $19^m.7$ already on September 21, 22, 24, and 25, and at the end — like a diffuse, faint small spot of $20^m.5$.

Literature. IC, Nos. 1920 — 1963; KTs, Nos. 28 — 30; PASP, No. 459; Astron. J., Vol. 71, 1966, p. 457.

The orbit is by Dinwoodie and Freeman (BAAH, 1965).

In agreement with the principles expounded in the book Fotometriya komet (Photometry of Comets) (Kiev, 1966), corrections ($-2^m.0$ — $-1^m.5$) were introduced into E. Roemer's estimates to reduce them to an integral magnitude. On the average, $H_{10} = 11^m.9$ from E. Roemer's estimate; a systematic fading of the comet was noticed in the 8-day interval, which might have been due to the difficult observation conditions in view of the comet low position.

r and Δ: September 7, 1965 — 2.61, 2.96; September 27 — 2.44, 2.99; October 17 — 2.60, 2.96.

1966 II — 1966c

It was discovered by Roberto Barbon (of the Asiago Astrophysical Observatory) on plates taken August 15, 1966, with the 48-inch Schmidt camera of the Mount Palomar Observatory. Upon discovery, the comet was 9^m, and it appeared to be diffuse with a central condensation and a tail from 10' to 20' in length, and it was located at the position $\alpha = 0^h48^m.5$, $\delta = +0°07'$ (in the constellation Cetus).

The comet was discovered independently in New Zealand by Alan Tomas of the Mount John State University Observatory on a photograph taken August 19; from his estimate, m = 9^m, and the tail was in the direction p = 270°. During September, October, and November, it slowly shifted southward.

On August 19 — 21, it was observed at the Smithsonian satellite station in Australia, Peru, and in Hawaii. On August 19, McNeil (Ascot) estimated the comet brightness to be 12^m, and he noticed a sharply condensed central coma 20" in diameter and a very faint outer coma of approximately 2' in diameter. On August 21, Botson visually estimated m = 10^m and a barely noticeable tail. On August 23, according to K. Tomita's observations, the comet was diffuse with a central condensation and tail longer than 1°. On August 23 and 24, according to the estimates of K. Tomita and Miran'yan, the comet was 11^m. On August 24, G. Denuayel' (Uccle) estimated the comet brightness to be 12^m, and on August 26, L. Debeon' described the comet as a hazy object of 12^m with a noticeable central condensation. On August 27, Price (U. S. Naval Observatory) observed the comet with a 15-inch astrograph and estimated its brightness to be 11^m. McNeil, on September 12, and Price on September 17, estimated the comet brightness to be 12^m, and on October 7, B. Mints estimated it to be $12^m.5$.

In August, the comet was observed by the Kiev University expedition (Ivanchuk, Andrienko), and their brightness estimates were: August 24 — 10^m, August 25 — 10^m, August 27 — $9^m.5$, and August 29 — $10^m.2$.

On August 22, D. A. Rozhkovskiy (Alma-Ata) described the comet from photographs with a Schmidt camera as a diffuse object of 11^m with a central condensation and tail < 1°.

Comet Barbon was observed at the Krimean Astrophysical Observatory during the period of August 21 — September 22 and October 16 — 21. In August, its integral brightness was estimated to be 10 — 11^m (Chernykh), and the comet appeared to be a nebulosity 0'.5 in diameter with a sharp central condensation and a faint tail 1 — 2'. /23

M. Beyer (Bergedorf) estimated the integral brightness, the brightness of the nucleus, and the diameter of the coma on August 24.98 and September 13.98, 18.98, 19.98, 20.98, and 22.98: the following values were obtained for the stellar magnitudes m of the comet: 10^m.76, 11^m.13, 10^m.86, 11^m.01, 10^m.45, and 10^m.58. The brightness of the nucleus remained within the limits of approximately 13 — 14^m. The diameter of the coma in August was 4'.3 and 2'.8 — 3'.8 in September.

The comet was observed at Abastumani on August 23 — 26, 1966, by I. R. Beytrishvili.

E. A. Dibay and V. F. Esipov, at the southern station at the Shternberg Astronomical Institute (Krimea), observed the comet spectrum on August 26, September 12, and October 16. A strong continuous spectrum and the C_2 4737.5165 Å bands, weakening with time, were noticed.

At the Skalnate Pleso Observatory, M. Antal determined the comet integral brightness to be 11^m.6 on September 4.8 and 11^m.9 on September 12.9 from plates taken with the 30-cm astrograph.

In spite of the stable fading of its brightness, the comet was observed until the end of the year. On December 10, the comet was photographed by E. Roemer with the Catalina 61-inch reflector and was visible with the 6-inch guide telescope (consequently, it

could not have been fainter than 12 — 13^m). There was a well condensed nucleus of 17^m with traces of a coma visible on the plate.

Literature. IC, Nos. 1966 — 1992; KTs, Nos. 43 — 53; PASP, Nos. 464 — 466; Circ. Rep. Obs. Johannesburg, Vol. 7, No. 126, 1967; Bull. Astron. Inst. Netherl. Suppl. s., Vol. 3, No. 3; Quart. Journ. RAS, Vol. 8, H 3, AN, p. 291 and H 6, p. 240, 1967 and 1969 VII.

The orbit was by G. Sitarskiy (IC, No. 1990); T = April 17.777, 1966.

The initial orbits were calculated by D. Marsden (IC, Nos. 1969 and 1970), M. Mamedov (KTs, No. 44), and N. Bokhan (KTs, No. 46). The orbit of Sitarskiy (IC, No. 1990) based on 77 observations from August 19 until October 21, is cited in the list. Based on preliminary data, $H_{10} = 6^m.5$ (Marsden). M. Beyer obtained a value of $H_{10} = 5^m.35$ from his own observations. On the basis of the 20 estimates of other observers cited above, we obtained $H_{10} = 5^m.70 \pm 0^m.18$. Thereupon, the December estimate of E. Roemer was reduced to an integral magnitude with the theoretical correction $-2^m.5$, which agrees well with the estimates of M. Beyer for the nucleus.

The average of Beyer's values and the values cited above for H_{10} can be taken as the final value of the absolute magnitude of Comet Barbon 1966 II: $H_{10} = 5^m.52$. The maximum value of the head diameter, reduced to unit distance, was $D_1 = 5'.9$ (in August) and $4'.6$ (in September).

The tail length, according to K. Tomita's observations, was $S = 0.047/0.204) \cdot 1.59 = 0.33$ a.u. on August 23 (the phase angle was $K = 13°$). The tail, judging from its length, was evidently of type I.

r and Δ: August 15 — 2.47, 1.55; August 23 — 2.52, 1.59; /24
September 2 — 2.60 and 1.62; September 12 — 2.66, 1.68; October 2 — 2.80, 1.82; October 22 — 2.96, 2.07; November 11 — 3.12, 2.40; December 1 — 3.31, 2.82; and December 21 — 3.47, 3.26.

1966 III — 1965d

The short-period comet Van Biesbroeck (1954 IV) was rediscovered by E. Roemer (Flagstaff) on May 1, 1965, in the constellation Virgo at the following position: $\alpha = 11^h48^m.6$, $\delta = +6°29'$.

With a 90-minute exposure, the comet had the appearance of a faint but completely sharp and definite stellar image of about $20^m.0$. The comet followed Milbourn and Lea's ephemeris and Marsden's corrected ephermeris well. The initially announced rediscovery by K. Tomita turned out to be related to a minor planet. Later, K. Tomita discovered, on his April 24.48 plate taken with the 74-inch Okayama reflector, the stellar image of Comet Van Biesbroeck, as he also did on earlier plates (March 27 and April 5) taken with the 36-inch reflector of the Dodeyra station. The comet was estimated to be $19^m.2$ on all three plates, and on May 22, 1965, E. Roemer observed the comet. The observations agreed well with Marsden's ephemeris on the basis of Milbourn and Lea's elements. The comet was observed at Flagstaff also at the end of the year, and eight observations of the comet were made by Van Biesbroeck in 1966 from May 15 until October 16, with the help of the 61-inch reflector of the Lunar and Planetary Laboratory of the University of Arizona (Catalina station).

During the summer months of 1966, M. Antal at the Skalnate Pleso Observatory, using a f/5 12-inch astrograph, observed the comet, as did Pereyra at the Cordoba Observatory, and also N. S. Chernykh and T. Smirnova at the Krimean Astrophysical Observatory. On June 15 and 20, the comet had a diffuse circular coma approximately 20" in diameter with a condensation and stellar nucleus having a brightness of m ≈ 14 — $14^m.5$ based on observations at the Krimean Astrophysical Observatory. The nucleus had h ~ 16 — $16^m.5$. On July 20, the diameter of the diffuse circular coma was 30" and its brightness was approximately 15^m. On October 16, 1966, E. Roemer estimated h = 17^m; the comet appeared to be somewhat more diffuse than the stars.

The comet continued to be observed in 1967; on October 6, 1967, Van Biesbroeck estimated the comet to be 18^m on a plate taken with the 61-inch telescope; it appeared to be a faint circular nebulosity evidently without a condensation.

Literature. IC, Nos. 1906 — 2013; KTs, Nos. 26 — 48; PASP, Nos. 458 — 464; Quart. Journ. RAS, Vols. 7, 8, 9 (Porter); Astron. J., Vol. 71, Nos. 449, 456, and Vol. 72.

The orbit is by S. Milbourn and G. Lea (BAAH, 1965); T = July 17.70, 1966.

The absolute magnitude was determined with certainty to be $H_{10} = 10^m.1 \pm 0.2$ from the ten weighted estimates over a 2.5 year period, when a correction (-1 — $-1^m.5$) was applied to E. Roemer's magnitudes for the nucleus. $H_{10} = 10^m.2$ for the pre-perihelion portion of the orbit; for the post-perihelion portion — $H_{10} = 9^m.8$, and $D_1 = 0'.7$ (July 20, 1966). /25

r and Δ: March 31, 1965 — 4.18, 3.20; April 20 — 4.09, 3.21; May 10 — 3.99, 3.32; June 19 — 3.80, 3.69; December 26 — 2.90, 3.62; January 15, 1966 — 2.80, 3.35; March 16 — 2.60, 2.45; May 15 — 2.47, 1.66; June 4 — 2.44, 1.50; July 14 — 2.41, 1.42; July 24 — 2.42, 1.41; September 12 — 2.45, 1.97; October 12 — 2.51, 2.32; November 11 — 2.59, 2.75; December 1 — 2.65, 3.03; October 16, 1967 — 4.06, 3.10.

1966 IV — 1966d

A new comet was discovered by the Japanese amateur astronomer Kaoru Ikeya (Sidzuoka) on September 8 as a circular diffuse object of 8^m in the constellation Coma Berenices at the following position: $\alpha = 13^h02^m$, $\delta = +22°16'$. It was discovered independently by Edgar Everhart (Mansfield Center, Connecticut) on September 12 as an object of 9^m with a central condensation or nucleus. The comet was discovered more than a month after its perihelion passage (T = August 5.24, 1966). It moved southeastward until the middle of September, then it moved through Booetes and Serpens. At the beginning of November, it crossed over into the southern hemisphere.

On September 13 and 14, it was observed by G. Suli (Bordeau Observatory); on September 14, according to M. Honda's estimate, and on September 17, according to Miranyan's estimate (U. S. Naval Observatory), it was diffuse with a nucleus, and the comet brightness was 10^m. On September 15 — 22, they unsuccessfully searched for the comet at Kiev with binoculars. It was undoubtedly fainter than 7 — 8^m. On September 15 — 21, the comet was observed at the Smithsonian Astrophysical Observatory, and on September 14 — 22 and October 7 — 13, the comet was photographed at the Krimean Astrophysical Observatory by N. S. Chernykh (Figure 8). In September, it had the appearance of a circular

nebulosity 1 — 2' in diameter with a condensed central portion. In general, the images were faint. A narrow, straight tail about 5' in length was visible on photographs taken with a 30-minute exposure.

M. Beyer observed the comet on September 13 until October 17. He found the comet to be difficult to observe. From September 13 until October 17, the comet faded from $9^m.0$ to $10^m.6$. E. Roemer saw the comet on October 16 in the finder of the Catalina station reflector (therefore, the comet could not have been fainter visually than 12 — 13^m). However, success was not achieved in photographing it. On October 16 and 17, the comet turned up on the films of the Baker-Nan camera of the Florida station. Its last very faint image was recorded on October 27 at the Hawaii station of the Smithsonian Astrophysical Observatory.

On September 19 — 21, I. Boushka and Kohoutek, at the Bergedorf Observatory, obtained a spectrum of the comet with the fourth degree objective prism on the Schmidt 120/80 cm (f/3) camera with a dispersion of about 500 Å/mm at 4000 Å. The faint continuous spectrum of the comet dust component and emission bands of CN, C_3, C_2, CH, NH_2, CO^+, and CO_2^+ were observed in the comet spectrum.

On October 17, at the southern station of the Shternberg Astronomical Institute, Ye. A. Dibay and V. F. Esipov obtained a spectrum of the comet using the 125-cm reflector with a spectrograph at the Cassegrain focus with an image converter tube in the λλ4000 — 5800 Å region at a dispersion of 270 and 70 Å/mm. A faint streak of the continuous spectrum of the nucleus and the distinct bands $C_2$4737 and 5165 were noticed in the spectrum. /27

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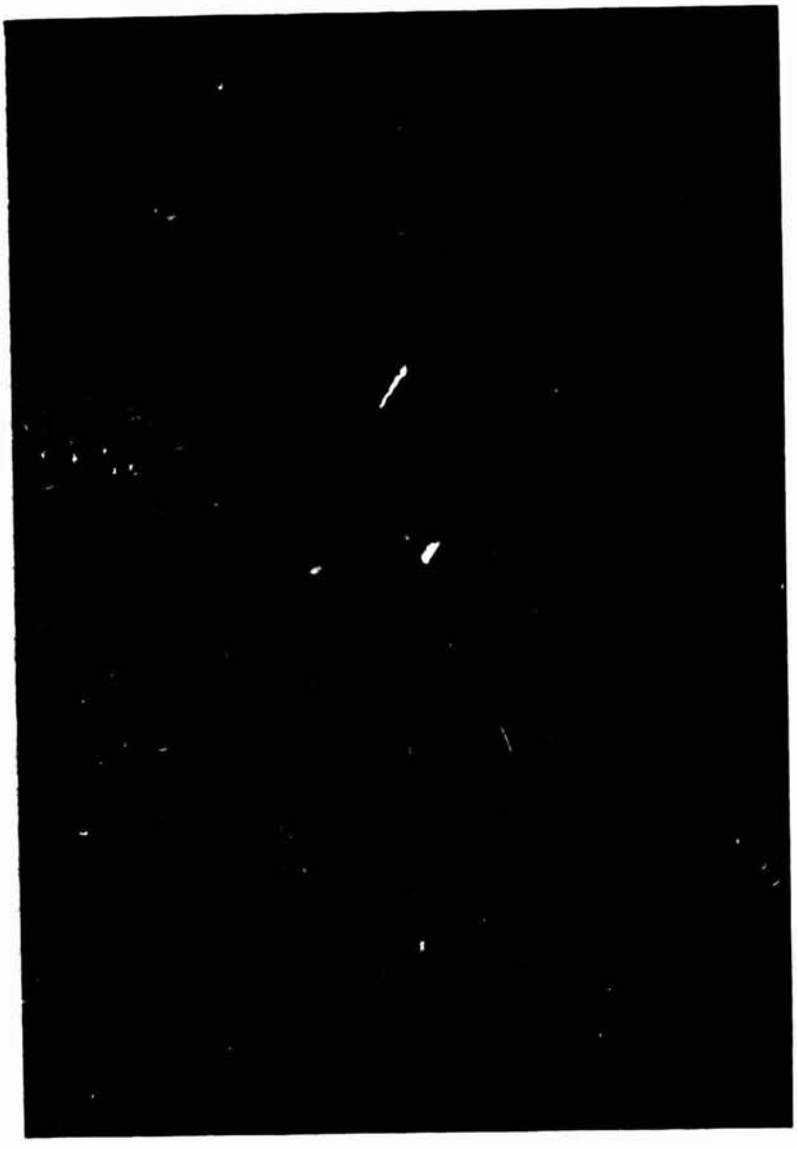

Figure 8. Comet Ikeya-Everhart 1966 IV (1966d). Photographed by N. S. Chernykh (KAO, 40/170 cm astrograph), September 15, 1966, 35-minute exposure.

Literature. IC, Nos. 1971 — 1994; KTs, Nos. 44 — 47; PASP, No. 467; Sky and Telescope, Vol. 32, No. 5, 1966, p. 263; BAC, Vol. 19, No. 3, 1968, p. 7; Quart. Journ. RAS., Vol. 8, p. 9; AN, Vol. 291, Hf 6, p. 241.

The orbit is by Sitarskiy and Cholkovskiy (IC, No. 1994); T = August 5.1992, 1966.

Based on preliminary estimates $H_{10} = 7^m.0$ (Marsden). On the basis of the data cited and mainly the observations of M. Beyer, the absolute magnitude is $H_{10} = 7^m.5$, and $D_1 \sim 7'$. The tail length is S = 5/3433 ~ 1.84 = 0.0027 a.u. (the phase angle for the middle of September was K = 29°). The tail, according to N. S. Chernykh's description, was evidently of Type I.

r and Δ: September 8 — 1.08, 1.82; September 18 — 1.18, 1.86; October 2 — 1.34, 2.02; October 22 — 1.60, 2.33; and November 1 — 1.69, 2.47.

1966 V — 1966b

This is a new parabolic comet with a large perihelion distance. It was discovered visually by S. Kilston, a student at a University in Los Angeles, on the evening of August 7, at the Likc Observatory in the course of photoelectric observation of a variable star in Hercules. Upon discovery, it looked like a diffuse object with $m = 10^m.6$ and a diameter of 30" and a central condensation, and it was found at the position $\alpha = 17^h55^m$, $\delta = +24°41'$.

It moved southward in Hercules until the end of August, it crossed Ophiuchus and Serpens in September in the southeastern direction, at the start of October, it crossed the Equator, and in October and November, it moved southeast through Aquila. At the end of November, it crossed into Capricornus and moved southeast. In the first half of August, it was observed at the Likc Observatory, the U. S. Naval Observatory, Skalnate Pleso, the Ascot Observatory, in Vienna, Brussels, Bucharest, Heidelberg, Tokyo, Dushanbe, and other places.

On August 10 — 12, according to the estimates of M. Antal, B. Mints, and Price, the comet brightness was 10 — 9^m, and on August 13, according to Miranyan (U. S. Naval Observatory, 15-inch astrograph), m = 10^m. P. Osherov and Filatov (Dushanbe) estimated the comet brightness to be 8^m. J. W. Young (Table Mountain Observatory) noted, on August 13.2, a broad straight tail 10' in length; on the following night, C. F. Capen visually observed a tail 15' in length.

From August 13 to 25, the comet was observed at the Krimean Astrophysical Observatory. It appeared to be a nebulous object of 8 — 9^m with a diameter of approximately 1', having a central condensation and a faint tail 2 — 3' in length on photographs of an hour exposure (Figures 9 and 10).

On August 14, W. S. Houston observed the comet with a 10-inch telescope at the Stellafane meeting of amateur astronomers in Vermont and noticed a coma diameter of 0°.5 and a faint tail of about 1° in length. The bright part of the coma had a diameter of about 1'. On August 14 — 16, the comet brightness, according /30 to Waterfield, Antal, and Simmons, was 10 — 9^m. On August 17 and 18, according to observations of Tomita, Antal, and Kristesku (Bucharest), m = 10^m. According to McNeil and Simmons, m = $9^m.5$. On August 19, the comet brightness, according to Waterfield, was $9^m.5$; according to Price and Simmons, on August 19 — 22, m = 10^m. On August 22, according to the observations of D. A. Rozhkovskiy (Alma-Ata), m = 8^m. And on August 23 — 25, according to the estimates of Tomita and Antal, it was 10^m. On August 28, the comet brightness was $10^m.1$ (Antal) and on August 31 — 9 — 10^m (Raudsaar). The comet was photographed in August — September at Abastumani (Beytrishvili), at Mayakakh (Odessa University, Zaginaylo), at the mountain station of the AOE (V. P. Engel'gardt Astronomical Observatory) near Alma-Ata (Tokhtas'ev, Dubyago, and

Figure 9. Comet Kilston 1966 V. Photographed by N. S. Chernykh (KAO, 40/170 cm astrograph), August 13, 1966.

others), at Tartu (Raudsaar), at L'vov (Laba), and at other places. In the first ten days of September, members of the expedition of the Kiev University Astronomy faculty, Andrienko, Ivanchuk, Churyumov, Rubo (Mount Sanglok of the Tajic SSR), Mile (Nice), McNeil (Ascot), Antal, Vol'tkh'yuz (Leiden), Mints

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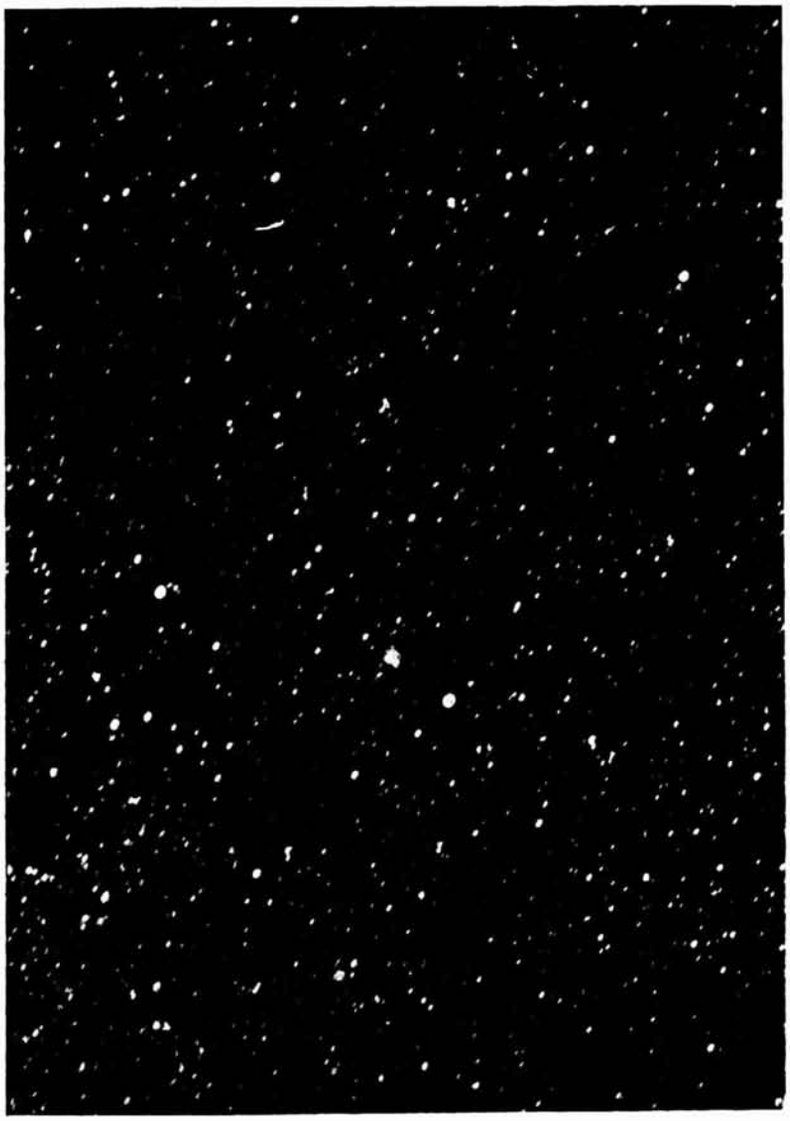

Figure 10. Comet Kilston 1966 V. Photographed by N. S. Chernykh (KAO, 40/170 cm astrograph), September 15, 1966.

(U. S. Naval Observatory), and Marks and Pfau (Iena), observed the comet. The following estimates were obtained: September 1 — 2, $m = 9^m.2$; September 4, $m = 9^m.5 — 9^m.9$; September 6 and 7, $m = 9^m$; and September 8, $m = 9^m.5$.

Later on, the following estimates were obtained: September 12, m = $9^m.5$ — $9^m.8$ (Waterfield, Antal), September 17, m = 10^m (Miranyan), and September 19, m = $9^m.5$ (McNeil).

In the second half of September, the comet was observed in Tartu and, according to the estimate of Kh. Raudsaar, m = 9 — 10^m.

On September 20 — 25, according to Vsekhsvyatskiy's estimates, the comet was $8^m.5$ — 9^m at Kiev with a strong condensation and a nucleus of $11^m.5$ — 12^m. A tail out to 2' was noticed on the photographs. M. Antal estimated, on September 29, the comet brightness to be $9^m.9$.

The comet brightness on October 4 was equal to 10^m (according to an estimate by Mints, U. S. Naval Observatory); on October 9 and 11 — $9^m.8$ and $9^m.9$ (Antal); on October 16 — m = 10^m (McNeil); and on October 18 — $9^m.9$ (Antal).

On November 5 — 7, according to the observations of N. S. Chernykh (Krimean Astrophysical Observatory), the comet was diffuse, with a central condensation, and m = 9^m. M. Antal estimated the comet brightness on October 9 and 16 to be $10^m.1$; and on November 28 and 29 — $10^m.8$ and $10^m.7$. Van Biesbroeck observed the comet at the Catalina station on September 17 until November 18; in November, it was diffuse, but with a short tail.

At the Skalnate Pleso observatory at Andrejov and Klet', A. Mrkos, I. Trenko, and V. Vanysek made photoelectric observations of the comet brightness in the BV system on August 13, 17, and 18; on September 11 — 12, and on October 6, 7, 8, and 9. On August 17, B - V = $0^m.86$, and in September and in October, $0^m.7$ (BAC, Vol. 19, No. 1, 1968, p. 43).

On November 22, 1966, V. A. Yakovleva, at the Byurakan station of Leningrad University, used the 50-cm refractor with a photoelectric photometer to determine the integral magnitude in the UBV system and the color indices: $M_V = 11^m.5$, $B - V = +0^m.83$, $U - B = 0^m.48$.

The large series of accurate photometric observations of M. Beyer and the photoelectric determination by K. Venske were published in the paper by M. Beyer in AN, Vol. 291, 1969, p. 241. /31 From August 12 until November 10, the comet brightness varied within the range $9^m.0$ — $10^m.7$.

Series of photometric observations of the comet were obtained by M. Antal (August 10 — December 8), A. M. Bakharev (August 12 — October 11), K. Simmons (August 14 — 23), M. Bortle (August 13 — 28), and I. S. Laba (L'vov, August 13 — 29).

Numerous photographs of the comet were taken at Kiev (Vsekhsvyatskiy, Kiev State University; Konopleva, Main Astronomical Observatory of the Ukrainian SSR Academy of Sciences). D. A. Andrienko and A. A. Demenko investigated the variations in the comet photographic brightness using these negatives and also other information.

On August 10, L. Aller took a spectrum of the comet with the nebular spectrograph of the Likc Observatory. Bright bands of cyanogen at 3883 Å and a reflected color were detected in the spectrum.

The comet spectrum was obtained with the 125-cm reflector of the Shternberg Astronomical Institute southern station (Krimea) on October 15 and 16, by Ye. A. Dibay and V. F. Esipov, with a dispersion of 270 Å/mm and on October 7 with a dispersion of

70 Å/mm. The continuous spectrum of the nucleus and bright bands of C_2 4737, 5165, and 5635 were detected. The cyanogen 3883 band was not detected due to absorption in the glass optics.

The last observation of Comet Kilston was made by Van Biesbroeck with the reflector of the Catalina station on October 6, 1967; the comet appeared to be a faint luminosity of 16^m.

Literature. IC, Nos. 1964 — 2010; KTs, Nos. 42 — 57; PASP, Nos. 464 — 471; Quart. Journ. RAS, Vol. 8, 1967; Vol. 9, 1968; Sky and Telescope, Vol. 32, 1966; Studii si cercetari astron. Acad. RSR, Vol. 12, No. 2, 1967; AN, No. 291, Hf 6, p. 241; in the collection Astrometriya i astrofiziki (Astrometry and Astrophysics), Vol. 4, Kiev, 1969.

The orbit is by G. Sitarskiy (IC, No. 2010); q = 2.385, P = 162,000 years.

According to preliminary estimates, $H_{10} = 4^m.5$ (Marsden). From the forty photometric measurements of M. Beyer and K. Venske, $H_{10} = 4^m.48 \pm 0^m.05$. The comet absolute magnitude determined from the entire collection of other estimates is: $H_{10} = 4^m.5 \pm 0^m.2$, i.e., it practically coincides with the values from M. Beyer's observations. The photometric parameters were determined uncertainly due to the small variation in r and the numerous outbursts of the comet brightness: y = 16.7; $H_y = 1^m.86$ (Beyer); $y = 0^m.7$; $H_y = 1^m.9$ (Konopleva). The maximum length of the tail (August 14, 1966) was S = 0.095 a.u. The phase angle was K = 21°.4. According to M. Beyer's measurements of the coma elongation, the tail deviated significantly from the extended radius vector (by 70 — 50°) and could not be a Type I tail.

An analysis of the variations in the comet brightness was made by V. P. Konopleva and G. A. Garazdo-Lesnykh on the basis of the series of observations at Kiev, the Skalnate Pleso Observatory, Dushanbe (Konopleva, Antal, Bakharev). A mean value of the color index of the comet coma equal to $+0^m.7 \pm 0^m.2$ was determined from the observations made at Kiev. Two outbursts in the brightness (August 13 — 25 and September 4 — 12) and their connection with processes on the Sun are noted.

From M. Beyer's observations, outbursts are separated out on /32
August 19, September 15 — 22, and October 19 — 22, when the comet increased in brightness by $0^m.2$ — $0^m.5$. M. Beyer found the photometric parameters $H_0 = 6^m.0$ and $n = 4.6$ ($y = 11.5$) for the brightness of the nucleus. The absolute magnitude of the nucleus is $h_{10} = 6^m.3$ from his data. The values of the reduced coma diameter D_1 varied within the range 5' — 7'.5 as if in parallel with the brightness variation, which M. Beyer compares with the curve with Wolf numbers for the comet.

r and Δ: August 8, 1966 — 2.55, 1.90; August 18 — 2.51, 1.96; August 28 — 2.48, 1.94; September 12 — 2.44, 2.00; September 22 — 2.42, 2.07; October 2 — 2.40, 2.15; October 22 — 2.39, 2.34; November 11 — 2.39, 2.56; December 1 — 2.42, 2.80.

1966 VI — 1966a

This was the fourth observed apparition of the short-period Comet Neujmin 1. It was rediscovered by Andrews (Boyden Observatory) from Kh. Raydsaar's ephermeris on May 16, 1966, in Norma at the following position: $\alpha = 16^h01^m$, $\delta = 43°39'$. Upon discovery, it was diffuse and without a central condensation or tail, and $m = 17^m$. One can suppose that the diameter of the diffuse

image could not have been less than 10". The comet was observed at Boyden Observatory on May 16, 17, and 24 as a diffuse object of 17^m and on May 26 as 16^m.

On June 23 and 24, it was photographed by Pereyra with the 60-inch telescope at Bosque-Alegre as a stellar object of $15^m.5$ — 16^m without a tail and without a gaseous coma. In May, the comet was in Norma, and in June, it passed into the constellation Lupus. It is possible that the comet was still observed by A. Hoag on August 7, 1967, using the 36-inch reflector of the Kitt Peak Observatory; however, the image was faint and identification with the comet was uncertain.

Literature: IC, Nos. 1945 — 2025; KTs, Nos. 37 and 40; PASP, Nos. 460 — 464; Quart. Journ. RAS, Vols. 8 and 9, 1968.

Kh. Raudsaar's orbit (KTs, No. 37; IC, No. 1950) satisfies the observations with a correction $\Delta T = 0^d.68$; T = December 11.000, 1966, P = 17.933 years.

The absolute magnitude on the basis of seven estimates was $H_{10} \sim 11^m.0$. Taking D > 0'.2 for the observations in May of 1966, we obtain $D_1 > 0'.4$ — 0'.3.

r and Δ: April 25, 1966 — 1.95, 2.11; May 15 — 2.79, 1.83; July 4 — 2.63, 1.67; and July 14 — 2.31, 1.60.

1967 I — 1966f

This was the eleventh observed apparition of the short-period Comet Grigg-Skjellerup (1902 II — 1961 IX; the returns in 1907, 1912, and 1917 were missed). The comet was recovered by K. Rudnitskiy (Warsaw) from observations with the 48-inch Schmidt

Palomar camera on December 19.5, 1966, almost exactly at the position corresponding to that calculated by Sitarskiy, and it was located in Libra: $\alpha = 14^h25^m.4$, $\delta = -23°18'$. Upon discovery, it appeared diffuse with a central condensation or nucleus: $m = 16^m$, almost $1^m.5$ weaker than according to the ephermeris. Later, E. Roemer detected a possible image of the comet partially masked by the trail of a star on a plate taken with the 61-inch reflector (Catalina) already on December 10. /33

Attempts to observe the comet at the Tokyo stations in the first half of January were unsuccessful. Evidently the comet was fainter than 18^m.

Literature. IC, Nos. 1962 — 2029; KTs, Nos. 42 — 47; Acta Astron., Vol. 16, 1966, p. 3; PASP, Nos. 464 and 466; Quart. Journ. RAS, Vol. 8, 1967; Vol. 9, 1968.

The orbit is by Sitarskiy (IC, No. 1962; Acta Astron., Vol. 16, 1966, p. 3). T = January 16.46, 1967 and P = 5.12 years.

The absolute magnitude was $H_{10} = 14^m.8$. The comet was $1^m.4$ fainter in comparison with its apparition in 1957.

r and Δ: Decembe 1, 1966 — 1.19, 1.59; December 11 — 1.12, 1.53; December 21 — 1.07, 1.49; December 31 — 1.03, 1.47; and January 10, 1967 — 1.00, 1.47.

1967 II — 1966c

This new comet was discovered by K. Rudnitskiy (Warsaw Astronomical Institute) at the Mount Palomar Observatory with the 48-inch telescope on October 15.4, 1966, in the constellation Cetus: $\alpha = 2^h38^m.7$, $\delta = 2°13'.5$. On discovery, it was diffuse

with a central condensation and with a tail 1' in length, and m = $13^m.5$.

Moving southwest, on October 21, it crossed the Equator and continued its southwesterly motion. At the beginning of December, it crossed into Aquarius, and towards the end of December — into Capricornus, where it was visible in the evening twilight sky. At the beginning of January, it disappeared in the evening twilight. Passing through perihelion on January 20, it was visible from January 28 in the morning sky, moving southwest in the constellation Sagittarius.

In October, K. Rudnitskiy (Mount Palomar Observatory), Mile (Nice), Van Biesbroeck (Lunar and Planetary Laboratory, Tucson, 61-inch reflector), and N. S. Chernykh (Krimean Astrophysical Observatory) observed the comet. On October 20 and 21, Van Biesbroeck estimated the comet as a diffuse object with a nucleus and a tail less than 1°, and a brightness of 13^m.

A large series of accurate observations was obtained at the Krimean Astrophysical Observatory by N. S. Chernykh and his coworkers from October 19 through December 30. The comet integral brightness increased rapidly. In the first week and the middle of November, according to Chernykh, the comet appeared as a diffuse object with a central condensation: m ~ 10^m, with a coma 1 — 2' in diameter. On November 15 — 16 and 20, B. Mints (U. S. Naval Observatory, 15-inch astrograph) estimated m = 11^m. On November 18, Van Biesbroeck found m = 9^m. According to the observations of K. Simmons (Jacksonville, Florida), on November 24, m = $10^m.7$ and D < 1'. On December 1, according to Pereyra's (Cordoba Observatory) estimate, m = 9^m. Many amateur astronomers in the USA, New Zealand, and other countries, observed the comet in December and estimated its brightness.

According to K. Simmons, on December 9 and 20, m = $8^m.5$ and $7^m.5$, respectively; a tail 20' in length and 2 — 3' in width. On December 29 and 30, N. S. Chernykh estimated the comet brightness to be 6^m and a tail approximately 0°.5. /34

A series of photometric estimates of the integral brightness was obtained from December 6, 1966, until January 2, 1967, by A. M. Bakharev (Dushanbe, Institute of Astrophysics) using a pair of Assembi binoculars. At first, it was diffuse with a coma diameter of 5'; then, a characteristic planetary nucleus and straight tail with a length of several tens of minutes was visible at the comet.

A. M. Bakharev's Estimates in the HD System

1966			1966		
December	6.64	$8^m.30$	December	26.56	$6^m.75$
	9.64	7.85		27.64	6.63
	13.64	7.72		30.56	6.15
	16.69	7.18		31.55	6.25
			1967		
	17.65	7.06	January	1.56	6.15
	18.62	7.30		2.56	6.20
	25.56	6.50			

On January 1, 1967, the comet had a Type I tail 80' in length on a photograph taken by K. Rudnitskiy with a 48-inch telescope (five-minute exposure). On January 4, it was observed the last time before conjunction by K. Simmons, disappearing in the morning twilight. After perihelion passage (January 20), it was first observed in the morning sky on January 28 by K. Simmons, and m = $6^m.8$. In the morning, it was independently discovered by Bennet (Pretoria) and also estimated to be $6^m.8$.

On February 6.8, the comet was observed by Kozai (Tokyo) and described as a diffuse object of 8^m without a central condensation. On February 8, it was observed by Mile. On February 11, Simmons and Bennet estimate in agreement m = $9^m.5$, and on February 20, m = $10^m.5$, according to the estimates of Bennet and Jones (New Zealand).

The comet continued to fade rapidly; the last measurement was made at Tokyo on February 28. E. Roemer did not detect traces of the comet on a plate taken on May 14 with the 61-inch reflector, although according to the ephermeris, its brightness should have been about 15^m.

Literature. IC, Nos. 1976 — 2001; KTs, Nos. 45 — 55; Sky and Telescope, Vol. 32, No. 6, 1966; Vol. 33, No. 3, 1967; Vol. 34, No. 2, 1968; PASP, Nos. 466 — 468; Quart. Journ. RAS, Vol. 8, 1967; Vol. 9, 1968; Astron. J., Vol. 72, No. 9, pp. 1164 — 1165; Acta Astron., Vol. 18, 1968, p. 3.

The orbit is by G. Sitarskiy and K. Cholkovskiy (IC, No. 1994); T = January 20.87, 1967, and a weak hyperbolic eccentricity, e = 1.00098.

According to preliminary estimates, the ephermeris absolute magnitude was 9^m (Bokhan) and $10^m.5$ (Marsden). $H_{10} = 9^m.63 \pm 0^m.09$ from the 13 photometric estimates of A. M. Bakharev (KTs, No. 55).

On the basis of the 45 cited estimates, $H_{10} = 9^m.8$. The /35
photometric parameters were: prior to perihelion, y = 12.0, H_y = $9^m.6$; after perihelion, taking $m > 16^m$ for E. Roemer's observation on May 14, 1967, we obtained y > 12.5, $H_y > 10^m.7$. The comet was rapidly depleted near and after perihelion; for December 6, D_1 = 2'.3. The maximum tail length (January 1, 1967) was S = 0.015 a.u.

The comet spectrum was obtained with an objective prism by S. Grudzinskaya and R. Barbon on December 11 with an 18-inch Schmidt camera. CN, C_2, and C_3 bands are present in the comet spectrum. The CN (0.0) band of the $B^2\Sigma^+ - X^2\Sigma^+$ (λ = 3880 Å) system and also CN (0 - 1) are very intense. Near λ4050 Å, a broad and intense C_3 group with three maxima near $\lambda\lambda$3940, 3990, and 4050 Å is observed. At r = 1 a.u., the 4214 Å band was more intense than the CN (0 - 0) 3880 Å band (Acta Astron., Vol. 18, 1968, p. 3).

Mayer observed the comet spectrum for five nights with a nebular photoelectric spectrophotometer at the Yerkes Observatory at the beginning of December. Mayer and O'Dell remarked, in the reference Astron. J., Vol. 72, p. 1164, about the presence of strong bands of C_2 (0 0), (1 - 0), (2 - 0), CN (0 - 0) and (1 - 0), and C_3 (4050).

The variation in the intensity of these lines was investigated as a function of heliocentric distance, and a similarity was noticed in the development of C_2 and CN. The evaporation temperatures of the parent particles for C_2 and CN (6000° K) and for C_3 (2000° K) were determined.

Literature. Astron. J., Vol. 72, No. 9, pp. 1164 — 1165.

r and Δ: October 15, 1966 — 1.94, 0.94; November 15 — 1.45, 0.58; December 1 — 1.20, 0.48; December 21 — 0.86, 0.41; December 31 — 0.67, 0.42; January 10, 1967 — 0.51, 0.48; January 30 — 0.48 0.92; February 19 — 0.83, 1.34; March 11 — 1.20, 1.59; and ' ' 0 — 2.17, 1.78.

1967 III — 1967c

This is a new comet discovered by P. Wild (Astronomical Institute of Berne University) on plates taken February 11, with a 40-cm Schmidt telescope at Zimmerwald. The comet had a brightness of 12^m and it looked diffuse without a central condensation or nucleus. It had a tail less than 1° in length and was located 8° from the pole in the constellation Camelopardalis ($\alpha = 7^h16^m.5$, $\delta = +81°45'$). Rapidly moving southward, the comet crossed Camelopardalis and Auriga towards the beginning of March; in March it passed through Taurus and Orion, and starting in April, it entered the constellation Lepus. Rapidly fading and moving southward, it disappeared in the middle of April.

On February 13.13, Miranyan (U. S. Naval Observatory) and on February 13.97, Antal estimated $m = 11^m$; the comet was diffuse with a central condensation and a short tail less than 1° in length. According to Kozai's estimate (Tokyo, Baker-Nan camera), on February 13.4, $m = 10^m$.

On February 14.8, P. Wild estimated $m = 11^m$; the comet had a distinct central condensation and a broad tail 2 — 3' in length.

On February 28.5 and March 1, according to K. Tomita, $m = 10^m$, and it was diffuse with a central condensation and small tail.

In March, the comet was widely observed at Kiev, Tartu, the /36
Krimean Astrophysical Observatory, the Skalnate Pleso Observatory, Nice, Tokyo, Berne, Ascot, and also at many points by amateur astronomers and members of ALPO.

The comet was photographed at Kiev by S. K. Vsekhsvyatskiy with the 12-cm Astropettsval' camera, and he estimated the comet, on March 1.75, to be $11^{m}.5$ — 12^{m}, on March 2.72 — 12^{m}, and on March 9.72 — $12^{m}.5$. An elongation of the coma was noted (March 1) in the direction p = 30 — 60°; on March 2, two rays were noticed — outbursts with a length of 0'.5 in the direction p = 0 and 30°. M. Antal (Skalnate Pleso) estimated the comet brightness to be $11^{m}.7$ on March 1.8, $12^{m}.3$ on March 8, and $12^{m}.5$ on March 10.8.

On March 1, P. Lancaster-Brown visually estimated, in a 30-cm refractor, the comet brightness to be $10^{m}.4$, and he noticed a fan-shaped tail 4' in length.

On March 2 and 9, the comet was observed at Kiev at the Main Astronomical Observatory of the Ukrainian SSR Academy of Sciences (Stupin, Garazdo-Lesnykh) as a diffuse object elongated in the north-south direction with a brightness of $11^{m}.5$. According to the observations of K. Simmons (Jacksonville, Florida), on March 11, a coma 1' in diameter had a brightness of $11^{m}.5$, and on March 12 — a diameter of 2 — 3' and a brightness of $12^{m}.5$. According to Waterfield, on March 5, m = $10^{m}.0$, and on March 27 — $12^{m}.5$. Moving away from perihelion, the comet rapidly faded. On April 9, it was observed by P. Wild. E. Roemer described the comet as a well-condensed image of $15^{m}.5$ with traces of a coma towards the east on a plate of the 61-inch reflector taken April 10. Two days later, on April 12, the comet was observed for the last time by Mile at Nice.

Literature. IC, Nos. 1997 — 2033; Nos. 50 — 60; PASP, Nos. 467 — 468; Sky and Telescope, Vol. 33, No. 6, 1967; Strolling Astronomer, Vol. 21, Nos. 1 — 2; Quart. Journ. RAS, Vol. 9, 1968, p. 304.

Preliminary orbits were calculated by N. Bokhan and G. Kastel' of the ITA (Institute of Theoretical Astronomy) (KTs, Nos. 51 and 52). B. Marsden obtained a parabolic orbit from 49 observations covering February 11 — April 9 (Quart. Journ. RAS, Vol. 9, 1968, p. 319); T = March 2.529, 1967, q = 1.3272.

Preliminary values of H_{10}, adopted by N. Bokhan and G. Kastel' were $10^m.6$ and by B. Marsden — $10^m.5$. From the collection of cited observations (29 estimates), the absolute magnitude was $H_{10} = 10^m.3$, S ≈ 0.001 a.u., and $D_1 = 2'.8$.

On March 4, 8, 9, and 12, A. Mrkos, I. Tremko, and V. Vanysek carried out photoelectric observations of the comet in the UBV system using the cassegren focus of the Klet' (Czechoslovakia) Observatory reflector (50/700 cm). During the observations, m_V varied from $11^m.3$ to $11^m.7$. The color index B - V varied within the limits of $+0^m.74$ to $-0^m.43$ (BAC, Vol. 19, No. 1, 1968, p. 43).

r and Δ: February 9 — 1.37, 0.63; February 19 — 1.33, 0.47; March 1 — 1.33, 0.69; March 11 — 1.33, 0.92; March 21 — 1.36, 1.14; March 31 — 1.39, 1.37; and April 10 — 1.44; 1.59.

1967 IV — 1967b

This was a new comet discovered by Tsytomo Seki (Kochi, Japan) on February 4.8, using a pair of binoculars (20 x 120 mm), in the morning sky in the constellation Hercules. Its position was $\alpha = 18^h13^m.1$, $\delta = 22°21'$. Its discovery was made as a result of 165 hours expended on searches after his discovery of a preceding comet Seki 1965 VIII. Upon discovery, $m = 11^m$, and the comet was diffuse without a central condensation. In February, it moved in an eastward direction through Vulpecula into Pegasus, where, at the end of February, it was observed for the last time. /37

The night following its discovery, the comet was observed by Ts. Seki and on February 6.8, by Kozai, who estimated it to be 10^m. On February 8, Giclas (Lowell Observatory) described the comet as diffuse with a nucleus of 11^m, but Van Biesbroeck found the comet on February 10.6 and 13.6 to be 10^m, diffuse, and without a central condensation.

The comet was observed during February primarily at the Lowell Observatory, the Lunar and Planetary Laboratory, Skalnate Pleso, Tokyo, Kiev, Nice, and other observatories, and also by the amateur astronomer members of the ALPO section.

On February 9, McCants (Austin, Texas) estimated the comet to be $10^m.5$ in a 9.5-inch refractor; on February 11.4, K. Simmons (Florida), using a 3-inch reflector, found $m = 10^m.2$ and a coma diameter less than 0'.5.

On February 12, on E. Roemer's plate (155-cm reflector), a coma having a diameter of 0'.6 was noticed to have a narrow needle-like tail in the northwest direction. The brightness of the nucleus was $h = 16^m.5$. On February 16, M. Antal estimated the comet to be 9^m and diffuse without a nucleus, and on February 17, Giclas observed the comet to be $11^m$and diffuse with a central condensation.

According to the observations of S. K. Vsekhsvyatskiy at Kiev, the comet was $8^m.5$ on February 18.12 and diffuse with an elongation at $p = 270°$. Ts. Seki also estimated the comet brightness at this time to be $8^m.5$. On February 21.5, Middlebrook (Texas, 8-inch reflector) found $m = 10^m$ and a coma diameter of 2'.

According to plates taken at Kiev with the dual-camera astrograph (12/70 cm), V. Konopleva and V. Stupin determined the photographic and photovisual magnitudes of the comet head and central condensation. On February 12.16, $m_{pg} = 9^m.0$; on February 17.16 — $m_{pg} = 9^m.1$; and on February 18.16 — $m_{pg} = 9^m.6$, $m_v = 8^m.6$. The photographic magnitude of the central condensation was $h_{pg} \sim 11^m.5 — 12^m$. The photovisual magnitudes were 1^m brighter. The comet evidently was redder than a G0 star.

The comet was observed for the last time prior to conjunction at Tokyo on February 28.

Literature. IC, Nos. 1996 — 2006; KTs, Nos. 49 — 52; PASP, Nos. 467 — 468; Sky and Telescope, Vol. 33, No. 3, 1967; Quart. Journ. RAS., Vol. 9, 1968, pp. 304 — 321.

The preliminary orbit was calculated by G. Kastel' (KTs, No. 50), and B. Marsden obtained a parabola based on 9 accurate observations covering February 6 — 22; I. Hasegawa found an ellipse (T = March 13.766, 1967, q = 0.457, and P = 4420 years) from 3 observations made during the same period (Quart. Journ. RAS, Vol. 9, 1968, p. 318). The preliminary value of the absolute magnitude was $H_{10} = 11^m.6$ (Kastel').

From the cited collection of estimates, the absolute magnitude was $H_{10} = 10^m.5$, $D_1 \approx 2'$ (February 21.5), and $S \sim 0.001$ a.u. (February 12).

r and Δ: February 9, 1967 — 0.89, 0.96; February 19 — 0.72, 0.95; March 1 — 0.56, 1.08.

1967 V — 1967a

This was the ninth observed apparition of the short-period Comet Tuttle (Saturn family); it was noticed the last time in 1939 (it was not observed upon its return in 1953).

It was rediscovered on January 3.48, 1967, by K. Tomita (50-cm f/2 Schmidt, Dodeyra station of the Tokyo Observatory) near the ephermeris position. Independent preliminary calculations of the comet were made by B. Marsden and P. Kandell and F. Narin (Illinois Institute of Technology, Chicago), as well as by V. K. Abalakin and N. A. Belyaev (Institute of Theoretical Astronomy, Leningrad). Upon discovery, the comet was in Lacerta ($\alpha = 22^h30^m$, $\delta = +42°9$), and it appeared diffuse without a central condensation, and $m = 15^m$.

Several images of the comet were discovered by K. Tomita on plates taken on December 2 and 4 with the 36-inch reflector of Tokyo Observatory. At this time, the comet was situated in Cygnus and was 16^m.

Moving southeastward, it crossed the constellation Lacerta, and then, in February — Andromeda and Pisces. At the end of March, passing through Aries, it entered Taurus. At the end of April, it crossed the Equator, moving into Eridanus. Continuing to move southeastward, it became a difficult object for northern hemisphere observers from the end of April.

On January 4.48, $m = 15^m$ (Tomita). On January 7, E. Roemer described the comet as a well-condensed object of 18^m with traces of a coma based on plates of the 61-inch reflector.

Mile (Nice) noticed an intense nucleus and faint diffuse coma on January 12.4 and 14.8.

During the entire period of visibility, the comet was observed mainly at Tokyo, Tartu, the Skalnate Pleso Observatory, the Catalina station, and by amateurs in the USA. On January 17, K. Tomita found m = 12^m.

E. Roemer, estimating the nuclear condensation to be 16^m, noticed a remarkable increase in the comet brightness on February 11. The comet was easily visible in the finder telescope and could not have been fainter than 11 — 12^m. K. Simmons visually estimated m = $11^m.0$ on this same night, using an 8-inch reflector. However, on February 10, M. Antal (Skalnate Pleso) found m_{pg} = $13^m.1$. Subsequently estimates of M. Antal were: March 1.7 — m_{pg} = 12^m, March 10.7 — m_{pg} = $11^m.2$, m_v = $10^m.7$; March 23.7 — m_v = $10^m.4$.

According to Simmons, on February 26 and March 2, D = 0'.5; on March 11 and 12 — m = 12^m, D = 1'.

After perihelion passage (March 31), the comet was observed by K. Tomita on April 3, when he found m = 9^m. According to the observations of K. Simmons, on April 24, m = $9^m.9$ and the coma was 2' in diameter. The last observation of its position was made on April 30 by L. Boethin (Abra, Philippines).

Literature. IC, Nos. 1953 — 2018; KTs, Nos. 48 — 60; PASP, Nos. 463 — 468; Sky and Telescope, Vol. 33, No. 3, 1967, p. 6; Quart. Journ. RAS, Vol. 8, 1967; Vol. 9, 1968.

Preliminary orbits were calculated by V. K. Abalakin and N. L. Belyaev (KTs, No. 38; IC, No. 1988) and by F. Narin (IC, No. 1953). The observations follow well B. Marsden's orbit with the correction $\Delta T = +0^d.1$ (IC, No. 1991); T = March 31.21, 1967, q = 1.023, P = 13.78 years. The mean value of the absolute magnitude was $H_{10} = 10^m.0$. /39

A rapid increase in the comet integral brightness was noted in March and April, which was undoubtedly connected with an especially high level of solar activity during its year of maximum. In March and April, the comet passed through a region of the most active heliographic latitude.

1967 VI — 1967i

This was the third observed apparition of the short-period Comet Arend (1951 X, 1959 V). It was rediscovered by K. Tomita on October 5.8 at the position near the ephermeris BAAH, 1967 (Milbourn and Lea) in the constellation Lynx: $\alpha = 8^h43^m.3$, $\delta = +39°19'$. It appeared as a diffuse object of 18^m without a central condensation. It moved eastward, and in November, crossed into Leo Minor.

On November 4, E. Roemer photographed the comet at the Catalina station. The comet appeared definitely to be a nonstellar, faint, diffuse object with a central condensation, and its integral brightness was $m = 18^m.5 — 19^m.0$.

There is one more possible observation of the comet carried out on September 8 by Van Biesbroeck. On a single plate taken with the 61-inch reflector, the comet appeared to be an almost stellar object of 18^m. But this observation was not confirmed on a second plate.

Literature. IC, Nos. 1965 — 2016; KTs, Nos. 55 — 59; PASP, Nos. 471 — 472; Quart. Journ. RAS, Vol. 9, 1968.

The orbit was by S. Milbourn and G. Lea (BAAH, 1966); T = June 13.71, 1967, P = 7.76 years.

The absolute magnitude from two estimates (a correction of -1^m was introduced into E. Roemer's estimate) was $H_{10} = 13^m.3$.

r and Δ: September 7, 1967 — 1.98, 2.34; September 27 — 2.06, 2.25; October 17 — 2.15, 2.15; and November 6 — 2.24, 2.03.

1967 VII — 1967f

This was a new bright comet discovered independently by several Australian and South American observers. Herbert Mitchell (Queensland) first detected the comet on June 29.4 low in the evening twilight. On July 1.3, M. Johns (Maryborough, Queensland) discovered the comet, which had a brightness of 5^m and a bright greenish tail several degrees in length. An independent discovery of the comet was made on July 2.9 by F. Gerber (Lucas Gonzales, Argentina).

The comet was discovered after perihelion passage (T = June 16.8, 1967). Prior to this, it could not be observed, as it was in conjunction with the Sun. At its discovery, it was located in the constellation Cancer and moved southeastward. On July 8, it crossed the Equator and passed through Sextans, Hydra, and Crater (about August 1), and in August it moved through Hydra into Centaurus.

The observation conditions were favorable only for observers /40 in the southern hemisphere. During the entire period of visibility, the comet was observed at stations of the Smithsonian Astrophysical Observatory in Australia, South America, and Africa. A series of accurate positions and brightness estimates was obtained by Pereyra (Cordoba Observatory). Numerous observations of the comet were made by amateur astronomers in Australia, South America, and the southern USA.

The comet brightness during the first days of July was estimated to be 5^m or somewhat brighter; the comet had a nucleus and a tail several degrees in length.

On July 2, Johns and other members of the Mourton Bay Amateur Astronomy Club, using a 10-inch refractor, observed a coma 5' in diameter and a long tail about 4° in length with a strong greenish coloration and consisting of fine streamers. On July 3, at the Smithsonian Observatory station at Island-Lagoon (Australia), a split tail 7° in length was photographed; on July 4, an identical tail 4° in length. On July 5, a tail 6° in length was photographed at the Woomera station. The integral magnitude was 4^m, and the comet was diffuse with a central condensation.

On July 4, $m = 4^m$, according to the estimates of Matchetta and Mida (Brisbane, Australia) and McCants (Austin, Texas). On the same day, Saugster (Houv, South Australia) observed a tail 4°.5 in length and a coma 3' in diameter.

From July 6 through the 15, the comet brightness was 4^m according to the estimates of observers of the Smithsonian observatory station, and on July 16, 5^m (Woomera, Olithantsfontein).

According to the estimates of amateur astronomers in Morston Bay (Brisbaine, Australia), the comet brightness on July 5 and 6 was 5^m, on July 7 and 8 about 6^m, and on July 11, 15, and 16 about 7^m.

Pereyra obtained a series of photographs with the 13-inch astrograph of the Cordoba Observatory. From July 3 through 9, the split tail was from 3 to 7° in length on the plates. According to estimates with the naked eye, $m = 3^m.2 — 4^m.5$.

On July 6, A. and B. Peydzhi (Brisbane) detected on photographs with an f/4.5 astrograph a diffuse coma without condensation, $m = 4^m.8$, a narrow tail 7° in length, and a second tail 2° in length in the northeast direction. On July 8, Matingley (Brisbane) observed in a 12.5-inch reflector, a coma 8' in diameter with a narrow central condensation and a tail with faint radiating ejections. On this same day, Jose Olivales (Mission, Texas) estimated in pair of 7 x 50 binoculars the comet brightness to be $m = 5^m.5$, and he noticed a tail 2° in length which had a bright northern edge. On July 10, according to J. Bennet's estimate (Pretoria), $m = 6^m.2$ and the tail was 3° in length.

Towards the end of July, the comet brightness faded to 7^m (Woomera, Island Lagoon), and on August 1, $m = 8^m$. On July 29, the diameter of the head was determined at the Woomera station to be 0°.2, and the length of the tail was 1°.5 and of the fainter part — 0°.2. On August 4 and 6, the comet brightness increased to 4^m. In August and September, the comet rapidly faded. In the middle of August $m = 10^m$. On September 6, the comet photographic magnitude was $12^m.0$ (Pereyra), and estimates of the same order were made at the stations of the Smithsonian observatory. On September 26, $m = 12 — 13^m$, and the comet was diffuse without a tail. /41

Literature. IC, Nos. 2021 — 2041; KTs, Nos. 55 — 59; PASP, Nos. 470 — 472; Sky and Telescope, Vol. 34, Nos. 2 and 3, 1967; Quart. Journ. RAS, Vol. 9, 1968; Strolling Astronomer, 1967.

The orbit was by Z. Sekanina (KTs, No. 59; IC, No. 2038); T = June 16.785, 1967, q = 0.178. The preliminary estimate of the absolute magnitude was $H_{10} = 6^m.0$ (Sekanina).

The absolute magnitude based on the selected 37 brightness estimates was $H_{10} = 5^m.1$, and $D_1 = 13'.4$ (July 4), S = 0.11 a.u. (July 3).

One of the tails was evidently of Type I; the shorter tail was possibly of Type III.

r and Δ: July 1 — 0.50, 0.74; July 9 — 0.73, 0.96; July 21 — 1.01, 1.16; July 29 — 1.18, 1.35; August 8 — 1.38, 1.59; August 16 — 1.53, 1.79; October 2 — 2.32, 2.92.

1967 VIII — 1967m

This was the eighth observed apparition of the short-period Comet Borrelly (1905 II — 1960 V). The 1939 and 1946 returns were missed. It was discovered by K. Tomita (Dodeyra station of the Tokyo Observatory) on October 5, 1967, with the 91-cm reflector. During a single night, Tomita rediscovered four short-period comets (Wolf, Wirtanen, Arend, and Borelly), which is an eminent record.

The comet was diffuse on the plate, with a central condensation and $m = 16^m$. It was discovered in Leo Minor ($\alpha = 10^h45^m.3$, $\delta = +28°51'$), not far from Marsden's ephemeris position.

In October and November, it moved almost exactly eastward along the boundaries of Leo and Ursa Major, and it passed through Coma Berenices. In December, 1967, and in the first month of 1968, it moved in the constellation Canes Venatici, in February, north, and in March, April, and May, west and southwest.

It was discovered after perihelion passage (June 17.8, 1967). It was observed at the Tokyo station and also by E. Roemer at Flagstaff. On February 1, it appeared as a diffuse object of 18^m on a plate of the 188-cm reflector of the Okayama station (Tokyo Observatory). The last observation of E. Roemer was made on March 23 with the help of the 61-inch reflector of the Catalina station. A practically stellar nucleus was noticed surrounded by a very faint coma, and $m = 19^m.5$. It was not found on plates of the Dodeyra station on April 21 and of the Catalina station of April 27, 1968.

Literature. IC, Nos. 1962 — 2037; KTs, Nos. 58 — 59; PASP, No. 473; Quart. Journ. RAS, Vol. 9, 1968; Vol. 10, 1969.

The orbit was by B. Marsden (Quart. Journ. RAS, Vol. 9, 1968, p. 318), $q = 1.447$, $P = 6.99$ years.

The absolute magnitude was $H_{10} = 12^m.5$ (of the two estimates, E. Roemer's value was corrected by $-1^m.0$), and the comet had not weakened after its seventh apparition in 1960.

r and Δ: October 5 — 1.86, 1.44; November 6 — 2.06, 2.41; /42 December 16 — 2.33, 2.29; January 25 — 2.60, 2.14; February 14 — 2.74, 2.10; March 25 — 3.00, 2.19.

1967 IX — 1967g

This was the eighth observed apparition of the short-period Comet Finlay (1886 VII — 1960 VIII, the 1913, 1933, and 1940 returns were missed). It was rediscovered by Van Biesbroeck (Lunar and Planetary Laboratory, Tucson, 61-inch reflector, Catalina station) on August 7.44 and independently by K. Tomita (Tokyo Astronomical Observatory, 91-cm reflector) 7 hours later (August 7.74). Both observers estimated the comet brightness to be 14^m. K. Tomita noticed a nucleus on the plate. Van Biesbroeck described a very diffuse circular coma about 1' in diameter with a small central condensation on the basis of visual observation.

Upon discovery on August 7.44, the comet was located in Taurus ($\alpha = 4^h39^m.7$, $\delta = 20°29'$), and it was moving eastward. B. Mile (Nice) photographed the comet on August 11 and 15 using the Veiss double astrograph, and he estimated the comet brightness to be 14^m. Further attempts by Van Biesbroeck to observe the comet in September and October were unsuccessful.

Literature. IC, Nos. 1990 — 2033; KTs, Nos. 57 and 58; PASP, No. 471; Quart. Journ. RAS, Vol. 9, 1968.

The orbit was by B. Marsden and K. Aksnes (IC, No. 2028); T = July 28.158, 1967, P = 6.902 years.

Based on the two estimates, the absolute magnitude was $H_{10} = 12^m.5$. By comparison with the mean value of H_{10} in 1960, the comet was brighter by 1 — $1^m.5$, which is also undoubtedly connected with the high level of solar activity in 1967.

r and Δ: July 29 — 1.08, 1.00; August 8 — 1.09, 1.03; August 18 — 1.11, 1.10; September 7 — 1.22, 1.18.

1967 X — 1967d

This was the fourteenth observed apparition of the short-period Comet Tempel-2 (1873 II — 1962 VI, the 1884, 1889, 1910, 1935, and 1941 returns were missed). It was rediscovered independently by E. Roemer (with the 61-inch reflector of the Catalina station) on February 12.5 and by K. Tomita (with the 74-inch reflector of the Okayama station of Tokyo Observatory) on February 12.8 as an object of 19^m in Ophiuchus. The comet position agreed well with Marsden's ephermeris: February 12.83, 1967, $\alpha = 16^h05^m.9$, $\delta = -7°38'$.

In February — May, the comet moved in Ophiuchus and Serpens towards the east and northeast. In June and July, it moved south through Scutum and Sagittarius. In August, during the period of perihelion passage, it was near ξ and θ Sagittarii. In September and October, it crossed Microscopium and Piscis Austrinus. In December, it moved into Aquarius. Numerous accurate determinations of the comet position, brightness estimates, and descriptions of its shape were made by E. Roemer (61-inch reflector), Pereyra (with the 13-inch astrograph of the Cordoba Observatory), Mile (Nice), Waterfield (Ascot), Antal (Skalnate Pleso), and also by amateurs in Australia and the southern USA. /43

On March 22, according to E. Roemer, the comet (actually the central condensation) had a stellar appearance and a brightness of 19^m; on April 11 $m = 18^m.2$.

On May 13, E. Roemer noticed a faint trace of a tail elongated towards the west, and the brightness of the nucleus was 16^m; on May 18, Pereyra found $m = 12^m.8$. As the comet neared perihelion, its geocentric distance decreased ($\Delta = 0.39$ a.u. at the end of July), and its brightness rapidly increased.

On June 6, Waterfield and Antal estimated m = $12^m.5$, on June 12.9 and 14.98, m ≈ 12^m, and on June 29, m = $11^m.5$.

The English comet observer P. Lancaster-Brown estimated m = $11^m.8$ on June 13.

On July 3, E. Roemer noticed a sharp stellar condensation of 14^m situated at the apex of a fan-shaped coma extended in the northwestern direction as far as 0'.1. On July 5, the comet brightness was equal to 11^m, according to Mintz' estimate (U. S. Naval Observatory), on July 8, m = $10^m.8$ (Waterfield), and on July 14, m = $10^m.6$ (Antal). From July 17 through 25, m = $10^m.8$ (Waterfield, Matchett in Australia, Polley in Arizona) and on July 27 — $10^m.5$ (Waterfield).

On August 3, P. Lancaster-Brown (Bikonsfield, Bakinhemshire) determined m = $9^m.5$, and 12 hours later, Matchett (Australia), observing the comet in more favorable latitude conditions, found m = 9^m. On August 7, Van Biesbroeck noticed a tail 3' in length at p = 310°. On August 26 and 27, after perihelion passage (T = August 14.2, 1967), the comet brightness was equal to $8^m.4$ and $8^m.2$ (Matchett). On September 4, m = $7^m.8$ (Jones), and on September 5.8, B. Mile estimated a nuclear condensation of h = $11^m.0$ (double astrograph). On September 26, the comet integral brightness was equal to $8^m.5$, according to Bennet, who found the comet accidently, and 16 hours later, $8^m.9$ (Jones). On September 30, E. Roemer found a stellar nucleus of $15^m.8$ situated at the apex expended north of the coma as far as 0'.1 on a five-minute exposure.

On October 5.8, B. Mile estimated m = $11^{m}.7$, and on November 4, E. Roemer observing with the 61-inch reflector noticed a tail extended northward and a sharp nucleus at the apex of the tail, whose photographic magnitude was $17^{m}.0$. The comet was barely visible in a 6-inch reflector. The comet integral brightness on November 6 was $12^{m}.0$ and on November 25, m = $12^{m}.1$ (Jones). The last observation at Tokyo was on January 1, 1968. The brightness curve shows that the comet experienced strong outbursts in August and September, evidently associated with the activity of solar corpuscular streams, which are especially intense during a period of maximum solar activity.

Literature. IC, Nos. 1982 — 2043; KTs, Nos. 53 — 60; PASP, Nos. 468 — 472; Sky and Telescope, Vol. 33, No. 6, 1967; Vol. 34, No. 6, 1967; Quart. Journ. RAS, Vol. 9, 1968.

The orbit is by K. Aksnes (IC, No. 2033; KTs, No. 58); q = 1.3665, P = 5.264 years.

The comet appeared significantly brighter (by 2 — 3^{m}) than its own precalculated magnitude (H_{10} ~ 12^{m}) upon its approach to perihelion, and near and after perihelion.

The reduced values of H_{10} near and after perihelion were about $8^{m}.0$. The May and June estimates, and also the November values, of m (taking into account theoretical corrections of $1^{m}.5$ — $2^{m}.5$ to E. Roemer's observations) give H_{10} ~ $11^{m}.0$ — $11^{m}.0$. The mean value of H_{10} for the 1967 apparition was $10^{m}.4$. The effect on Comet 1967d Tempel 2 of conditions in interplanetary space varying with solar activity appeared to be especially pronounced.

D. Maisel, drawing attention to the comet great brightness at its 1967 apparition, asserted in PASP No. 582, doubts as to such a rapid rate of disintegration of periodic comets as has been established in the papers of S. K. Vsekhsvyatskiy, Z. Sekanina, V. P. Konopleva, F. Whipple, and others. In the paper of S. K. Vsekhsvyatskiy devoted to this problem [Problemy kosmicheskoy fiziki (Problems of Space Physics), 1971, No. 6], the importance of studying the brightness variations and outbursts of comets is emphasized, and the groundlessness of the total conclusion of D. Maisel is proven.

r and Δ: February 9 — 2.31, 2.90; March 11 — 2.05, 2.37; April 10 — 1.79, 1.84; May 10 — 1.70, 0.84; June 19 — 1.49, 0.50; July 29 — 1.38, 0.39; August 18 — 1.37, 0.43; September 27 — 1.45; 0.65; October 17 — 1.53; 0.82; November 6 — 1.63, 1.04; November 26 — 1.74; 1.29; and December 16 — 1.87, 1.58.

1967 XI — 1967e

This was the fourth observed apparition of the short-period Comet Reinmuth 2 (1947 VII, 1954 VI, 1960 IX). It was discovered by Tomita (Dodeyra station of Tokyo Observatory, 91-cm reflector) on June 5 — 7, 1967, almost exactly in the position predicted by E. Rabe in Aquarius: $\alpha = 22^h43^m.6$, $\delta = -5°51'$. The comet was diffuse without a central condensation, and its brightness was 18^m. It moved north and northeast during June and July through Pisces into Pegasus. In August — November, it moved in Pegasus.

Two nights after its rediscovery, E. Roemer photographed the comet using the 61-inch reflector of the Catalina station. The comet was almost a stellar object on the plate with $h = 18^m.2$; on July 3, the faint image of the comet was scarcely brighter than $18^m.5$ (E. Roemer). On August 18, the comet passed through perihelion, and in September and October, Mile (Nice, Zeiss double

astrograph), M. Antal (Skalnate Pleso, 30-cm f/5 astrograph), and N. S. Chernykh (Krimean Astrophysical Observatory) observed the comet.

According to Mile's estimates, on September 5.9 and 7.99, the comet brightness was $14^m.6$ and $14^m.7$. On September 12.99, $m = 15^m.0$, and on September 14 E. Budding and J. Herrok (Wilfred Hall Observatory, 40-cm astrograph) estimated $m = 15^m$. On September 30, E. Roemer estimated the stellar nucleus surrounded by faint traces of a coma to be $h = 17^m.5$.

On October 5.6, according to Mile, $m = 15^m.5$. On September 7, according to Antal, $m = 15^m.4$. /45

In November, the comet brightness unexpectedly increased. On November 2 and 4, according to the observations of Van Biesbroeck and E. Roemer (61-inch reflector), the integral magnitude was $m = 13^m$, the diameter of the coma was 8", and the brightness of the nucleus was $h = 17^m.8$.

Literature. IC, Nos. 2003 — 2058; KTs, Nos. 53 — 62; PASP, Nos. 468 — 472; Quart. Journ. RAS, Vol. 9, 1968.

The orbit was by E. Rabe (IC, No. 2033; KTs, No. 53); $q = 1.9421$, $P = 6.735$ years. The value calculated in advance was $H_{10} = 11^m.2$ (E. Rabe).

The mean value of the comet absolute magnitude based on 12 estimates (taking into account corrections for the transition from h to m): $H_{10} = 11^m.7$. The absolute brightness of the nucleus was $h_{10} = 14^m.0$, $D_1 \sim 0'.8$ (September), and $\sim 0'.2$ (November).

At the end of October or at the beginning of November, the comet flared up by almost 3^m, exhibiting, similar to other short-period comets of 1967, special activity during a year of maximum solar activity.

r and Δ: May 30, 1967 — 2.05, 1.78; June 19 — 2.00, 1.54; July 9 — 1.97, 1.33; July 29 — 1.95, 1.16; August 18 — 1.94, 1.03; September 7 — 1.95, 0.97; October 17 — 2.00, 1.09; November 6 — 2.05, 1.26; November 26 — 2.11, 1.49.

1967 XII — 1967j

This was the eleventh observed apparition of the short-period Comet Wolf 1 — Kamenskiy, which was discovered in 1884 and has been observed at every return with the exception of 1905. The comet was discovered by E. Roemer on plates taken September 30.3 and October 1.3 (1967) using the 155-cm reflector of the Catalina station (Tucson). The comet was starlike, and $m = 19^m$. It was independently discovered by K. Tomita on October 5.6, using the 188-cm reflector of the Okayama station. According to his description, it was diffuse with a central condensation or nucleus, and $m = 18^m$. The comet was in the constellation Pisces ($\alpha = 1^h04^m.4$, $\delta = +13°31'$).

In October, it moved southwest in the constellation Pisces. One more recorded observation of the comet was made by E. Roemer on November 4 with the same instrument. The comet image was sharp and almost stellar, and $m \approx 18^m.5$ or somewhat fainter. The last observation was made on January 19, 1968, by K. Tomita (Tokyo), and $m = 18^m$.

Literature. IC, Nos. 2009 — 2037; KTs, Nos. 59 — 61; PASP, No. 472; Quart. Journ. RAS, Vol. 9, 1968.

The orbit was by G. Sitarskiy, based on M. Kamenskiy's theory (Acta Astron., Vol. 7, 1957, p. 1; IC, No. 2009); T = August 30.009, 1967, q = 2.506, P = 8.429 years.

The preliminary value of the photometric parameters were y = 15, $H_{10} = 10^m$ (Edgerton). The value of the absolute magnitude based on three estimates taking corrections into account was $H_{10} = 12^m.6$.

The comet was brighter by 1^m in comparison with the 1959 apparition, and this should also be attributed to the high level of solar activity. /46

r and Δ: September 27 — 2.51, 1.55; October 17 — 2.53, 1.53; November 6 — 2.55, 1.64; and November 26 — 2.58, 1.83.

1967 XIII — 1967h

This was the forty-eighth observed apparition of the short-period Comet Encke since its discovery by Mechain in 1786. It was rediscovered by N. S. Chernykh (Krimean Astrophysical Observatory) with a 40-cm double astrograph on August 30, 1967, as a faint circular diffuse object with a very insignificant central condensation. $m = 13^m.5$, and the diameter of the coma was 0'.5. It was found in Auriga ($\alpha = 5^h20^m$, $\delta = +31°15'$) at a position close to G. Kastel's ephermeris. It was independently discovered by K. Tomita on August 7.71. According to his description, the comet was diffuse without a central condensation and $m = 13^m$.

It moved almost exactly east; in August, it passed through the constellation Gemini and entered Cancer. A number of observations of the comet were made by N. S. Chernykh at the Krimean Astrophysical Observatory during the first half of August. At its last observation on August 16, the comet appeared to be more condensed, the diameter of the coma had increased to 1', and the brightness had increased to 12^m. At Dushanbe, A. M. Bakharev and Mukumov observed the comet occultation of the star BD + 32°1113 and estimated the comet brightness to be 11^m.

On August 25, K. Simmons (Florida) observed the comet and estimated m = $10^m.5$. As the comet approached perihelion, its brightness continued to increase. On September 2 and 3, G. Bortle (Mount Vernon, New York) noticed a brightness increase to $8^m.7$.

Literature. IC, Nos. 2014 — 2038; KTs, Nos. 54 — 58; PASP, No. 471; Quar.. Journ. RAS, Vol. 9, 1968.

The orbit was by G. Kastel' (IC, No. 2014; KTs, No. 54); T = September 22.049, 1967, q = 0.3382, P = 3.299 years.

The preliminary photometric parameters were y = 15, H_y = $11^m.5$. On the basis of the cited estimates (7), the mean value of the absolute magnitude was H_{10} = $11^m.4$, and D_1 = 1'.3 (August 16).

r and Δ: July 29 — 1.2, 1.57; August 8 — 1.04, 1.42; August 18 — 0.88, 1.24; August 28 — 0.70, 1.22, and September 2 — 0.60, 1.20.

1967 XIV — 1967k

This was the fourth observed apparition of the short-period Comet Wirtanen (1947 XIII — 1961 IV). It was found by K. Tomita

on October 5.73, 1967 ($\alpha = 3^h46^m$, $\delta = -2°33'$) in a position close to W. H. Julian's ephermeris.

It was a diffuse object of 15^m with a distinct nucleus. It was the brightest of the four comets rediscovered by K. Tomita from plates taken in the course of a single night. In October, the comet was moving in Eridanus. In November, it crossed into Taurus and moved northeast. From the end of February and in March, it was in Auriga. At the beginning of November (1.9), M. Antal (Skalnate Pleso, 30-cm astrograph) and N. Kojima (Ishiki, Japan) observed the comet. They found $m = 15^m$ — $15^m.5$. On /47
November 5, E. Roemer estimated the sharp central condensation to be $h = 18^m.5$ or brighter, surrounded by a small coma. On November 24.9, M. Antal estimated the comet photographic magnitude to be $14^m.8$. It was observed by Hirose and Tomita at the Dodeyra station (91-cm reflector) on February 21 as a diffuse object of 18^m.

After the comet perihelion passage (December 15.72), E. Roemer detected a faint diffuse image of the comet on March 24 on a plate taken with a 60-minute exposure at the Catalina station (61-inch reflector) and found $h \approx 19^m.5$. On April 27, 1968, it was not detected on a plate taken under exceedingly good conditions with a 60-minute exposure (evidently fainter than 20^m).

Literature. IC, Nos. 2019 — 2056; KTs, Nos. 47 — 61; PASP, Nos. 470 — 473; Quart. Journ. RAS, Vol. 9, 1968; Vol. 10, 1969.

The orbit was by B. Marsden (BAAH, 1968; IC, No. 2041; KTs, No. 61); $q = 1.6123$, $P = 5.654$ years.*

* Translator's Note: Smithsonian Catalog of Cometary Orbits lists this comet's period as $P = 6.65$ years.

Marsden pointed out the forthcoming in 1972 close approach (Δ = 0.28 a.u.) with Jupiter, which will decrease the comet period to 5.9 years.

The preliminary value of the absolute magnitude was H_{10} = $14^m.4$ — $14^m.7$ (Marsden, Imnadze).

Based on the cited estimates and Roemer's value of h (with a correction of $-2^m.5$), we get an absolute magnitude for the comet of $H_{10} \approx 14^m.3 \pm 0^m.3$ and $D_1 \sim 0'.1$.

r and Δ: September 17, 1967 — 1.84, 1.10; October 7 — 1.75, 0.90; October 27 — 1.69, 0.75; November 16 — 1.64, 0.6[illegible]; December 6 — 1.62, 0.66; December 26 — 1.62, 0.75; January 25, 1968 — 1.65, 0.95; February 14 — 1.72, 1.16; March 25 — 1.89, 1.66.

1968 I — 1967n

This was a new, bright comet discovered almost simultaneously (with a difference of only five minutes) by the well-known Japanese comet seekers K. Ikeya (Maisaka, Hamamotsu, 15-cm reflector) and Ts. Seki (400-km west of Kochi; 20 x 120 mm binoculars) in the morning sky on December 28.85, 1967. It was the fifth comet for each of these observers. At discovery, it looked diffuse without a central condensation, and $m = 8^m$. It was located in Ophiuchus ($\alpha = 16^h32^m$, $\delta = 2°06'$). It was moving northeast, then north. During January, 1968, it crossed Ophiuchus, and at the beginning of February, it moved into Hercules. Rapidly shifting north, in March it crossed Diconis; at the end of March, it passed through Ursa Minor, and on March 31, it was located less than 5° from the pole. In April, it moved south, and towards the beginning of May, it passed through Camelopardalis and Pisces.

During the summer months, the conditions for its observation worsened, since the comet went into conjunction with the Sun.

The comet was widely observed in 1968 in Japan (Tomita), in Nice (Mile), in the USA (Van Biesbroeck, Roemer, Miranyan, the comet section of the ALPO), in Kiev (S. K. Vsekhsvyatskiy, K. I. Churyumov), at the Krimean Astrophysical Observatory (N. S. Chernykh), in Dushanbe (A. M. Bakharev), and by others (Figures 11 and 12).

Shortly after its discovery, the comet was diffuse with m = 9^m, according to the estimates of Kozai on December 29.8 and Tomita (Tokyo Astronomical Observatory) on December 30.8 and 31.8 and on January 3.8. Tomita mentioned the presence of a nucleus. On January 5.4, 1968, Miranyan (U. S. Naval Observatory) estimated m = 9^m, and on January 6.2 Mile found m = 8^m. On January 7.9, according to Van Biesbroeck, m = 9^m, and the diameter of the coma was 30" and of the nucleus — 2". /48

In the second and third decades of January, the brightness estimates of the comet lay within the limits 9^m — $8^m.3$. On January 10.2 and 11.2, M. Antal estimated the comet visual magnitude to be $8^m.7$ and $8^m.5$. From January 12 through 22, according to the observations of Miranyan, Raudsaar (Tartu), and Bakharev (Dushanbe), the brightness was about 9^m, while Mile, evidently estimating the brightness of the central condensation, gives m = $10^m.7$. On January 18.7, R. Beycher (Tucson, Arizona, 4-1/2-inch reflector) visually observed m = $8^m.6$ and a coma diameter of 2'. On January 20.2, Mile noticed a tail 7' on a plate taken with a yellow VJ3 filter. From January 22 through 31, the comet visual magnitude lay within the limits $8^m.6$ — $8^m.3$, according to the observations of B. Mile, D. Smith (Winton, Virginia, 6-inch reflector), R. Beycher, and A. M. Bakharev. The coma diameter /50

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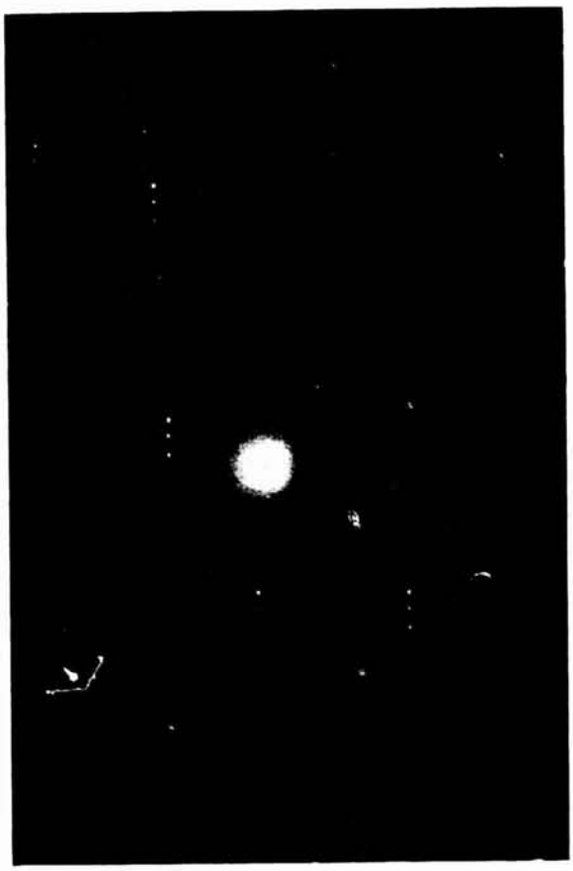

Figure 11. Comet Ikeya-Seki 1968 I. Photograph taken by K. I. Churyumov with the 2-m reflector of the Shemikhinskaya Observatory (prime focus, 9 meters), February 20.05, 1968, 13-minute exposure.

was 2' on January 5 (Beycher) and 3' on January 27 (Smith). A. M. Bakharev noticed a brightness increase of the comet on January 30 to 8.3; at the end of January, a planetary nucleus was observed which later disappeared. On February 1.7, R. Beycher gave $m = 8^m.3$, D = 4'; according to Bakharev on February 1.0, $m = 8^m.4$, and on February 2 and 3 — $8^m.6$. On February 4.1, according to the observations of N. S. Chernykh (Krimean Astrophysical Observatory, 40-cm astrograph), the comet photographic brightness was $6^m.5$ — 7^m, the head was melon-shaped, D = 3', with a sharp central condensation 1' and a tail 40 — 50' in length with radiating filaments.

On February 6.1, N. S. Chernykh, working under poor transparency conditions, estimated $m = 7^m.5$, D = 1'.5 — 2' (a head with a sharp central condensation) and a tail 20' in length. From February 5 through 9, the comet brightness was $8^m.5$ — $8^m.2$, according to the observations of Ts. Seki and Mile. On February 20 — 21, Ts. Seki, Kh. Raudsaar, K. Tomita, and N. S. Chernykh estimated the comet brightness to be $7^m.0$, A. M. Bakharev found $m = 7^m.7$ on February 22, and I. R. Beytrishvili (Abastumani) photographed a tail 1° in length.

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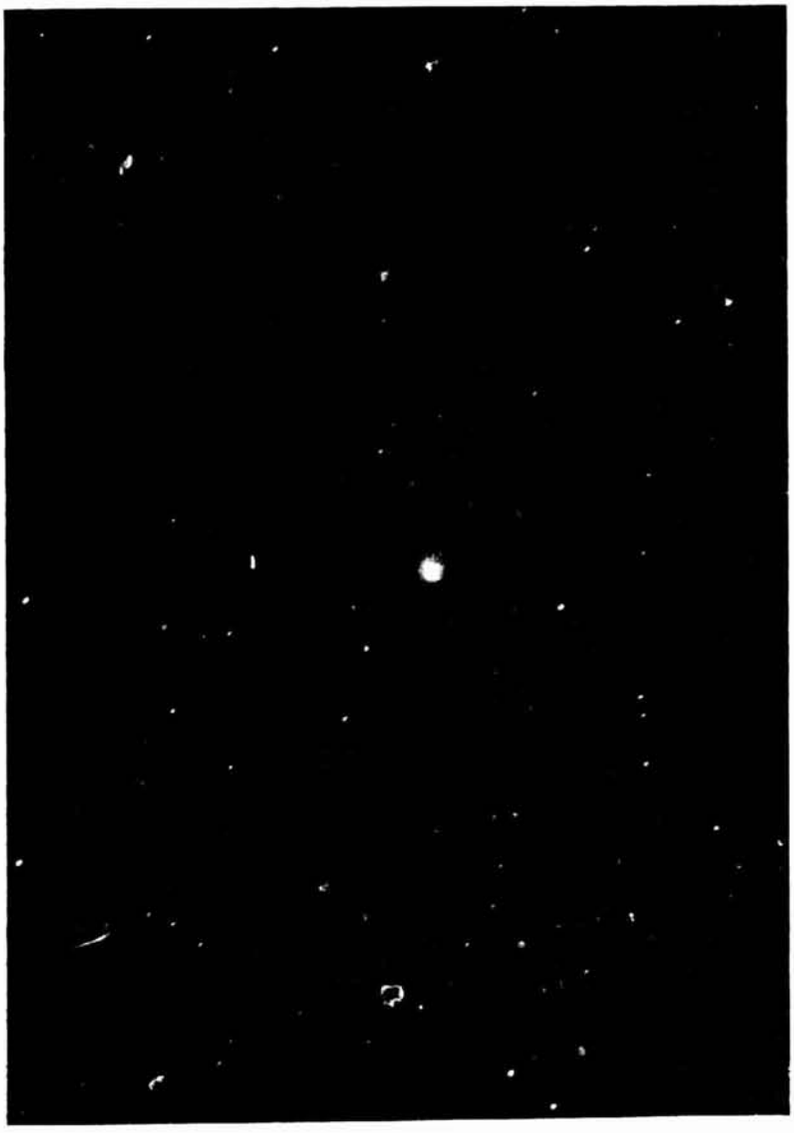

Figure 12. Comet Ikeya-Seki 1968 I. Photograph by Seki with a 15/95 cm reflector, March 4, 1968, 4-minute exposure.

Observers in Bulgaria, M. Gogoshev and Kazakov gave m = $7^{m}.5$ on February 24; on this same day, the tail length was C = 1° according to Beytrishvili, and according to Simmons (Florida), visually C = 0°.5 with a width of 1'.

At the end of February, D = 3' (Anderson, Manchester), and the diameter of the central condensation was 1' (Bortle, Delano, USA). On February 28.1, N. S. Chernykh photographed a broad diverging tail 0°.2 directed to the west on a 40-minute exposure. D = 3', there was a sharp central condensation, and m = 6 — $6^m.5$. On February 27, 28, and 29, m = $7^m.5$ according to Kh. Raudsaar and A. M. Bakharev; on March 1 and 2, m = $7^m.7$ (Bakharev). On March 3, Kh. Raudsaar, V. Viet-Knudsen (Tisvil'deleye Observatory), R. Switzer (USA), and Ts. Seki were in agreement in setting m ~ $7^m.2$. On March 4, Charles Kapen (Table Mountain Observatory), observing visually with binoculars, found m = 7^m and a tail length of C = 1°; on the same night, J. Delano determined m = 7^m.

From March 10, the comet was observed at Kiev (Vsekhsvyatskiy, Churyumov), with the Astropettsval' 12/60 and Telemar 15/100 cameras; the visual brightness was 8^m; a sharp central condensation was noticed. From March 13 through 24, the comet visual brightness was about $7^m.5$ according to the observations of Kh. Raudsaar and members of the Association of Lunar and Planetary Observers (ALPO) K. Simmons, R. Beycher, and others. Many observers noticed a sharp decrease in the comet brightness to $8^m.5$ — $8^m.8$ on about March 25 (Milon, Simmons, Beycher) and a decrease in its brightness to $9^m.5$ on about March 30. On March 31, the comet brightness increased to $7^m.5$, and then it again decreased to $8^m.5$ by April 3 — 4, according to Milon, Minton, Smith, and Wooten (ALPO).

On April 2, the comet had the appearance of a fuzzy nebulosity /51 of m = 9^m with a stellar nucleus of 11 — 12^m, according to the observations of S. K. Vsekhsvyatskiy and K. I. Churyumov. From March 26 until April 6, K. Pek (Cleveland, Ohio) estimated D = 3 — 4'. K. Simmons estimated a tail 3' in length during the first week of April. In the middle of April, the comet brightness

grew to 8^m — $8^m.5$ according to observations at Kiev (Vsekhsvyatskiy, Churyumov), Uzhgorod (A. T. Kirichenko, artificial Earth satellite station of Uzhgorod University), and also according to the observations of members of the comet section of ALPO (Bortle, Milon, Miller, Smith).

Towards the end of April, the comet faded from $8^m.8$ to 10^m, according to K. Simmons' observations. D = 1'.5. On May 4, m = 10^m (Vsekhsvyatskiy, Churyumov), and the brightness of the stellar nucleus was h = $11^m.5$ — $12^m.5$. On May 9, m = 9^m — $9^m.5$. K. Simmons noted that, during May, the comet diameter remained 1' — 2' and m = 9 — 10^m.

A remarkable series of photometric determinations of the comet integral brightness and the brightness of the nucleus were made from January 27 (m = $7^m.58$) until June 3, 1968 (m < $10^m.4$) by the well-known Bergedorf comet investigator M. Beyer. According to these determinations, the comet reached its maximum brightness ($7^m.2$) on March 2 and 3; a rise in brightness was noticed on March 24 and 26 (to $7^m.21$). Significant brightness variations of the coma and nucleus (within the range $9^m.0$ — $13^m.5$), the dimensions of the head, and the length and position of the tail and individual rays were observed. The value of the coma diameter D was recorded within the limits 3' — 16'. The series, which contains 87 estimates, also includes photoelectric determinations by K. Venske and several estimates of G. Bortle referring to the beginning and middle of January.

On September 22.3, K. Simmons found m = $13^m.7$; on September 29.3, K. Scovill and G. Bortle (Stamford, Connecticut) estimated m = $12^m.5$ and the brightness of the central condensation as h ≥ 14^m; n October 29, 1968, E. Roemer photographed a sharply condensed, almost stellar object of $16^m.2$; at the last observation

on November 23 with a 30-minute exposure, the comet appeared significantly brighter and was estimated to be m ~ 15^m.

Literature. IC, Nos. 2046 — 2101; KTs, Nos. 62 — 83; PASP, Nos. 472 — 473; Sky and Telescope, Vol. 35, Nos. 3 and 5, 1968; Strolling Astronomer, Vol. 21, Nos. 1 — 2; Quart. Journ. RAS, Vol. 9, 1968; AN, No. 6, 1969, p. 245.

The orbit was by B. Marsden (Ic, No. 2054; KTs, No. 66). T = February 25.717, 1968, q = 1.697, i = 129°31, a parabola with reverse motion. The preliminary values of the absolute magnitude were H_{10} = $4^m.3$ (Kastel'), $4^m.0$ (Sekanina, Kastel'), $4^m.5$ (Seki), $4^m.0$ (Marsden). The absolute magnitude, on the basis of the cited brightness estimates, was H_{10} = $4^m.46 \pm 0^m.3$; S = 0.045 a.u. (about March 22), and D_1 = 9'.5 (March 4).

According to Beyer, D_1 = 6'.9 — 18'.7. According to M. Beyer's determination based on 87 observations, the photometric parameters were y = 2.5; n = 14.67, and H_y = $3^m.12$. Thus, H_{10} = $4^m.27$. Taking the average of our value of H_{10} and M. Beyer's reduced magnitude, we get H_{10} = $4^m.36$ for the final value, which characterizes the physical peculiarities of this active comet during a period of heightened solar activity. /52

The comet spectrum was taken by K. McKraken (Goddard Space Flight Center) with a kassegren spectrograph having a dispersion of 104 Å/mm mounted on a 92.5-cm reflector on February 25 and 26 near perihelion. A continuum and bands of C_3 (λ4050 Å) and CN (λ3883 Å) were noted. Neither the Swan bands nor CO^+ emission were observed. An investigation of the brightness variations of the comet central condensation in the photographic and photovisual regions based on plates taken at Kiev and on the expeditions of Kiev University has been carried out by K. I. Churyumov and A. A. Demenko (KTs, No. 80). Photometry of the comet head was done by K. I. Churyumov (KTs, No. 80).

r and Δ: January 10 — 1.83, 2.38; January 30 — 1.76, 1.96; February 14 — 1.70, 1.62; March 5 — 1.70, 1.34; March 25 — 1.73, 1.38; April 14 — 1.80, 1.71; and May 14 — 1.98, 2.38.

1968 II — 1967i

This was the seventh observed apparition of the short-period Comet Schwassmann-Bachmann 2 (1929 I). It was discovered by K. Tomita on August 8.7, 1967 (seven months prior to perihelion) using the 91-cm (36-inch) reflector of the Dodeira station of Tokyo Observatory as a diffuse object of 18^m with a nucleus and a small tail. It was found near the ephermeris position (Marsden, Aksnes) in Taurus.

Moving eastward, it crossed Orion in September, and prior to December, it moved into Gemini, then towards the beginning of February it slowly shifted in retrograde motion to the northwest. In February and March, it traveled in Gemini.

In September, Van Biesbroeck observed the comet at $18^m.5$. On January 25 and 26, 1968, M. Antal (Skalnate Pleso) estimated the comet brightness to be $13^m.5$ on plates taken with the 30/150-cm astrograph. On February 17.48 and 19.56, Ts. Seki (Kochi Observatory, 15/94-cm astrograph) observed the comet at 13^m, and on February 21.6 — $13^m.5$. The positions in January — February were also determined at Tokyo and Nice. N. S. Chernykh at the Krimean Astrophysical Observatory noted on February 1.8 and 21.8 a diffuse coma 20 — 30" in diameter and a sharp stellar condensation of 15^m. On March 31, Van Biesbroeck estimated the coma diameter to be 6" and a broad tail 0'.5 in length in the direction p = 100°. With a ten-minute exposure on May 26, 1968, E. Roemer detected a well-condensed but not stellar image of $17^m.3$. It was observed until the end of 1968.

Literature. IC, Nos. 2015 — 2073; KTs, Nos. 55 — 80; PASP, Nos. 470 — 473; Quart. Journ. RAS, Vol. 9, 1968.

The orbit was by B. Marsden and K. Aksnes (Ic, No. 2015; KTs, No. 55); T = March 14.3201, 1968, q = 2.147, P = 6.516 years.

The preliminary values of the photometric parameters were y = 15, $H_y = 8^m.0$ which corresponds to $H_{10} = 10^m$. The average value of the absolute magnitude was $H_{10} = 10^m.1$ (based on six estimates) with the limits $9^m.2$ — $11^m.5$. A rise in brightness was noted in /53 January — February of 1968, which was evidently associated with the high level of solar activity; $D_1 = 1'.0$.

r and Δ: August 8, 1967 — 2.63, 2.96; September 7 — 2.51, 2.52; October 17 — 1.91, 2.39; December 16 — 1.28, 2.24; January 5, 1968 — 1.23, 2.20; January 25 — 1.28, 2.18; February 14 — 1.41, 2.16; March 5 — 1.59, 2.15; and July 13 — 2.70, 2.24.

1968 III — 1968f

This was a new comet discovered by P. Wild (Astronomical Institute at Berne) with the 40-cm Schmidt camera at Zimmerwald on October 17.0, 1968, 6.5 months after perihelion passage (T = April 3.85, 1968). Upon discovery, it was diffuse, without a central condensation, and $m = 15^m$. It was found in Perseus ($\alpha = 3^h00^m$, $\delta = +39°25'$).

It moved southwest, and towards the end of October, it crossed into Triangulum. Upon subsequent observations on October 17.9, 19, 20, 21, 22, 24, 25, and 26, P. Wild determined accurate position and estimated the comet visual brightness to be 14^m. He noted a sharp nucleus and traces of a faint tail 1' in length. On October 24.7 and 26.6, Ts. Seki found $m = 14^m.5$, and on October

27.6 — 15^m. On October 28.8, according to Seki's observations, m = 15^m. According to Waterfield, the comet was diffuse with a central condensation and m = 14 — 15^m. Roemer and Schreur found m = 16^m on October 28.24. Continuing observations in November, Ts. Seki found m = 15^m on November 1.8 and m = 16^m on November 17.7.

Literature. IC, Nos. 2106 — 2121; KTs, Nos. 75 — 76; Quart. Journ. RAS, Vol. 10, 1969.

The orbit was by B. Marsden (IC, No. 2121); T = March 31.25, 1968; q = 2.6091; i = 135°.2; a parabola with reverse motion.

The preliminary value of the absolute magnitude was H_{10} = $8^m.5$ (Marsden) and $7^m.0$ (Milbourn). Based on the cited estimates, H_{10} = $7^m.5 \pm 0^m.2$, D_1 = 1', and S = 0.004 a.u. (K = 11°).

r and Δ: October 21, 1968 — 3.34, 2.88; November 10 — 3.46, 2.52; November 30 — 3.59, 2.80; December 20 — 3.73, 3.22; and January 19, 1969 — 3.97, 4.01.

1968 IV — 1968a

This was a new comet discovered in Japan by several observers which received the name Tago-Honda-Yamamoto. On April 30.74 — 30.80, Universal Time (on the morning of May 1, local time), A. Tago, Ya. Sato, M. Honda, Sh. Fujikawa, and Kh. Yamamoto. The comet appeared as a diffuse object of 7^m without a central condensation and was found 5° north of α Andromeda. It was later clarified that the comet was first detected already on April 25.76 by K. Itagaki (Yamagata, Japan). However, the names of the discoverers were assigned to the comet in agreement with the sequence of communications about this discovery which arrived at the

International Center of Astronomical Telegrams.

The comet was moving northeast. In the first half of May, it moved along the boundary of Cassiopeia and Perseus, and in May, it moved in Camelopardalis.

On May 1 and 2, M. McCants and D. Wells (Austin, Texas) and /54
R. Minton (Las Cruces, New Mexico) of the cometary section of ALPO observed the comet and estimated m = 7^m. Dennis Milan communicated that D = 3'. In the first week of May, accurate positions of the comet were determined by K. Tomita, Ts. Seki (Japan), E. Roemer, N. S. Chernykh (Krimean Astrophysical Observatory, 40-cm double astrograph), and M. Honda (Kurashiki Observatory). The comet brightness during this period was about $7 — 8^m$ (Tomita, Chernykh, and Honda). However, on May 4 and 7, the comet was estimated to be 10^m by various observers (Baker-Nun cameras at Mount Hopkins). According to Seki, m = 9^m, D = 6'. From May 9, the comet was observed at Kiev (S. K. Vsekhsvyatskiy and K. I. Churyumov, Astropettsval' 12/60 cameras, Telemar 15/100, and the large 20/425 astrograph) and had a brightness of about $9^m.5$.

On May 8 and 9, Honda and Sibasaki (Tokyo Observatory) described the comet as diffuse without a nucleus, and m = 7^m. On May 8.3, J. Bortle (Mount Vernon) estimated the diameter of the circular coma to be 3' and m = $7^m.6$. On May 8.8 and 9.7, m = 7^m (Honda). On May 12.07, according to Waterfield's observation (England), the comet was exceptionally diffuse, and m = 8^m. In the second ten days of May, Kh. Raudsaar (Tartu), M. Antal (Skalnate Pleso), Waterfield, and N. S. Chernykh observed the comet.

On May 16.5, the comet passed through perihelion. According McCants' observations, the coma diameter was 3' on this day. According to E. Roemer, on May 17.45, m = 11 — 12^m (18-inch astrograph). On May 17.9, according to Waterfield, the comet was very diffuse and m = 7^m.5.

At Kiev, the comet appeared highly diffuse in the case of visual observations with a 10-inch refractor (Vsekhsvyatskiy) with a very faint nebulosity lacking a central condensation, and D = 1'. On May 24, Waterfield and Tomita found m = 8^m, and on May 25 and 26, Simmons (Florida) determined the coma diameter to be 2' and m = 9^m.4, using a 4-1/4-inch reflector. An important series of nine photometric observations of the total brightness of the head and nucleus and estimates of the coma and tail dimensions was obtained by M. Beyer (Hamburg-Bergedorf) during May 14 — June 3. These estimates are as follows:*

		m	m_k	d	D	C
May	14,92	$8^m,42$	$\sim 12^m,5$	2',9	7'	6
	23,95	9,35	$\sim$13,0	2,6	7	1
	25,98	9,23	$\sim$13,0	3,0	6	4
	27,95	9,69	<13,0	2,2	—	—
	29,96	9,78	<13,0	2,6	—	—
	30,96	9,99	$\sim$13,5	2,8	—	—
	31,96	10,28	<13,3	2,2	—	—
June	2,00	10,15	<13,0	2'	—	—
	3,96	<10,3		—	—	—

At the end of May, Kh. Raudsaar (Tartu), Mile (Nice), S. K. Vsekhsvyatskiy, and K. I. Churyumov (Kiev) observed the comet. On May 31, according to Waterfield's estimate, m = 8^m.5. The last observations of the comet were made by M. Antal (June 5) and K. Tomita (June 7).

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* Translator's Note: Commas in the numbers indicate decimal points.

The rapid recession of the comet from the Earth and the drop in its absolute brightness made further attempts to observe it unsuccessful. E. Roemer did not find the comet on August 28, /55 on a pair of plates obtained under good conditions with the 154-cm reflector. The comet was fainter than 20^m.

Literature. IC, Nos. 2072 — 2088; KTs, Nos. 68 — 70; PASP, No. 473; Sky and Telescope, Vol. 35, No. 6; Vol. 36, No. 2; Strolling Astronomer, Vol. 21, Nos. 1 — 2; AN, Hf. 6, 291, 250, 1969; Quart. Journ. RAS, Vol. 9, 1969.

The preliminary orbits were calculated by G. Kastel' at the Institute of Theoretical Astronomy and D. Marsden (KTs, No.69).

The orbit was by B. Marsden (IC, No. 2076; KTs, No. 70); T = May 16.204, 1968, q = 0.6804 a.u., i = 102°2 — a parabola with reverse motion.

The preliminary value was $H_{10} = 10^m.5$ (Kastel' and Marsden). On the basis of the cited estimates (except Beyer's observations), $H_{10} = 10^m.0$, $D_1 = 2'.8$, and S = 0.002 a.u.

Based on M. Beyer's observations, $H_{10} = 11^m.0$ (in the I_{pv} system); the photometric parameters were y = 13.9 and $H = 11^m.3$.

r and Δ: May 29, 1968 — 0.73, 1.19; June 8 — 0.82, 1.46; June 18 — 0.95, 1.87; and June 28 — 1.09, 1.85.

1968 V — 1968b

This comet was discovered by the amateur astronomer N. Whitteker (Bishop, Texas) visually with the help of a 4-inch reflector on June 15.2 and independently by N. Tomas (Lowell

Observatory) on June 17.2 at the edge of a plate taken with the 13-inch astrograph in the course of photographing the minor planet Icarus. Upon its discovery, it was characterized as diffuse with a central condensation or nucleus and $m = 9^m$, without a tail. It was found in Serpens ($\alpha = 15^h17^m$, $\delta = 5°$) and rapidly moved north. About June 25, it entered the constellation Corona Borealis, and at the beginning of August, it crossed its northern boundary. On June 19.2 and 21.1, according to Miranyan's observations (U. S. Naval Observatory), $m = 10^m$. On this same day, according to Waterfield, $m = 8^m$, and the comet was diffuse with a nucleus, and on June 23.95, $m = 9^m$. McCants and Wells estimated $m \sim 10^m$ on June 19, and a diameter of 12 — 15' for a weakly condensed coma. On June 24.2, Van Biesbroeck (61-inch reflector of the Catalina station) indicated $h = 12^m$, a coma of 1'.5, and a distinct condensation. S. K. Vsekhsvyatskiy (Kiev, Astropettsval' 11/60 camera) found the comet on June 24.8 and 26.9 to be diffuse, and $m = 9 — 10^m$, D = 3', with a faint central condensation. On June 21.8 — 24.8, in the vicinity of Vanovskiy of the Turkmen SSR, K. I. Churyumov found $m = 9^m.2 — 9^m.0$. On June 19.2, D. Mailon, K. Simmons, McCants, and other members of the cometary section of the ALPO, observed the comet to have $10 — 9^m$, D ~ 5', and on June 25 — 29, $m \sim 10^m$. I. Yang (Table Mountain) noted a stellar nucleus of 14^m on June 21, observing with the 24-inch reflector.

On June 28.9, N. S. Chernykh (Krimean Astrophysical Observatory) observed a diffuse coma of D = 2'.5 with a highly central condensation 25" in diameter and with a halo. On June 29 and 30, the comet brightness faded to $9^m.5$ (Waterfield, Kivil, Wulston Observatory), and on July 4 — to $9^m.8$. The comet nucleus was double on these plates, the fainter component at a distance of 30" in the direction p = 20°. At this same time, M. Antal (Skalnate Pleso) communicated $m = 12^m$. N. Tomas also found, in /56

July, m = 12^m. The comet rapidly lost its brightness. On July 20.9, it was not visible in a telescope (Milon). According to Waterfield's observation, m = 11^m on July 17.96 and m = 12^m on July 27.99. There was a central condensation of 14^m elongated in position angle 140 — 320° with a size of 20". The diameter of the exceptionally diffuse coma was 2'.5.

On July 25.56, Ts. Seki gave m = 14^m (evidently for the nucleus).

At the end of July, M. Antal at the Skalnate Pleso Observatory also observed the comet. K. Simmons found m = $10^m.7$ on July 15, using a 20-cm reflector, and $12^m.8$ on August 2. On August 22, Waterfield photographed the comet as an exceptionally diffuse coma of m = $15^m.0$. E. Roemer noted the comet as a small diffuse spot of m = $19^m.5$ — $20^m.0$ on a 60-minute exposure taken August 28; on September 22, the image was very faint and diffuse with m = $20^m.1$. However, Seki found m = 14^m on September 10.5, 1968.

Literature. IC, Nos. 2078 — 2098; KTs, Nos. 70 — 74; Sky and Telescope, Vol. 36, No. 2; Quart. Journ. RAS, Vol. 10, 1969..

The preliminary orbits were by S. Milbourn and B. Marsden (IC, Nos. 2079 and 2081; KTs, Nos. 70 and 71). The orbit was by B. Marsden (IC, No. 2086; KTs, No. 72); T = June 4.5031, 1968; q = 1.234003 a.u.

The preliminary value was $H_{10} = 11^m.0$ (Marsden). The mean value, based on 20 estimates, was $H_{10} = 10^m.3 \pm 0^m.2$.

Rises of brightness are noted on about June 21 and June 26 — July 4, and D_1 = 1'.8.

r and Δ: June 15, 1968 — 1.24, 0.29; June 19 — 1.25, 0.34; June 23 — 1.27, 0.40; July 1 — 1.30, 0.54; July 13 — 1.37, 0.76; July 23 — 1.44, 0.94; and August 2 — 1.52, 1.12.

1968 VI — 1968c

This comet was discovered visually by M. Honda (Kurashiki, Japan) on July 6.75, 1968, in the morning sky near Auriga as a diffuse object of 8^m without a condensation. An independent discovery of this comet was made by Sh. Fujikawa 20 minutes after Honda.

The comet moved northwards, and in August, it crossed Camelopardalis and Cepheus and entered Draco, passing, on August 27 — 28, 6° from the pole (Figure 13). In September, moving southward, it crossed Draco and Hercules; in October, it passed through Ophiuchus and moved in the constellation Serpens. Twelve hours after its discovery, E. Everhart, D. Milon, K. Simmons, and other members of the cometary section of the ALPO observed the comet. On July 7.3 and 8.3, $m_v = 8^m$, the brightness of the central condensation was $h = 11^m$, and the coma diameter was D = 3' — 3'.5; on July 11, $m = 8^m.5$. On July 16.0, Kh. D. Gul'medov and Khamidullina at the observatory in Firyuza (near Ashkhabad) estimated $m = 8^m$. On July 16.5, the comet was observed at the Kitt Peak Observatory (Van Biesbroeck, 85-inch reflector). On July 18, E. Roemer and Waterfield, who described it as diffuse with a nucleus and $m = 8^m$, observed the comet. On July 20 — 26, the comet brightness was about $7^m.5$ (Waterfield, Seki, observers of the ALPO). On July 23.0, M. Antal estimated $m = 8^m$ and D = 2', and a tail 11' in length on the plate. On July 24.0, Waterfield /58 photographed, with a 30-minute exposure, a broad fan-shaped tail with streamers 7' (p = 180°) and 4' (p = 340° and 270°) in length and noted a broad anti-tail 2' in length at p = 120°. On July

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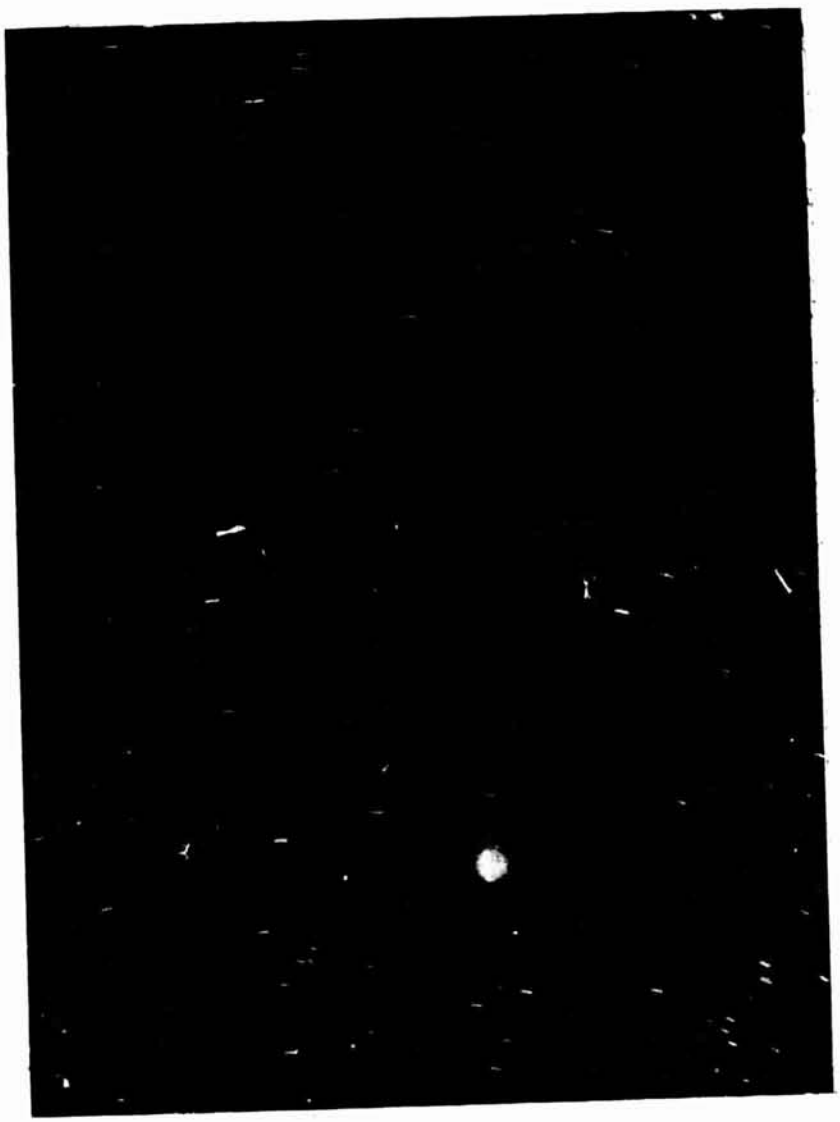

Figure 13. Comet Honda (1968 VI). Photographed by N. S. Chernykh (Krimean Astrophysical Observatory, 40-cm astrograph), August 27.848, 1968 with a 30-minute exposure.

26, according to the observations of Burnashevaya (Krimean Astrophysical Observatory), m = 7^m and the comet head was melon-shaped with signs of a tail. On July 27 and 28, K. Simmons (Florida) observed, in an 8-inch reflector, a split tail 10' in

length (at p = 280°) and a fainter one (at p = 260°). On July 29, according to Waterfield, the comet brightness was 7^m, and on July 30, Khamidullina (Firyuza) observed the comet to be diffuse with a central condensation of 8^m. On July 31.0, M. Antal estimated m = 6^m, and there was a rayed tail 2° in length and a coma 4' in diameter on the plate. K. I. Churyumov observed, on July 31, at Firyuza, a tail C = 45' in length, and on August 6 — 7, C = 1°.

On August 7, the comet passed through perihelion. On August 13, Waterfield found m = 6^m. S. K. Vsekhsvyatskiy (Kiev) found $m_v = 5^m.9$ and D = 5', on the basis of extrafocal comparisons made with a pair of binoculars. On August 29.8, $m_v = 5^m.7$; on August 30.88 — $m_v = 5^m.5$ and D = 5 — 6'; on August 31.85 — $m_v = 5^m.8$ and D = 6' and a tail 2° in length (Type I). On this same night, Waterfield noted a long and narrow tail 17' in length (p = 135°) and D = 5'. On September 3.8, $m_v = 6^m.2$ (Vsekhsvyatskiy); on September 4.8 — a central condensation of $6^m.5$, and on September 6 — $5^m.0$ (Waterfield). On September 12, Pereyra (Cordoba observatory) found m = 6^m, and on September 20 — 7^m. On September 21.7, S. K. Vsekhsvyatskiy estimated m = $5^m.7$ and P. Lancaster-Brown — m = $6^m.2$ at the site of the solar eclipse expedition at Yurgamysha in the Cordon region of the USSR. At about this same time, E. Roemer obtained, on photographs, a well-condensed nucleus of h = $13^m.6$ in a faint coma. Accurate positions of the comet were determined by B. Mile (Nice), Baume (Dresden), Jorgensen (Copenhagen), Van Biesbroeck, Waterfield, Antal, and Beytrishvili. On October 11, Pereyra (Cordoba) estimated m = $8^m.5$. According to Waterfield, on October 14.8, m = $7^m.8$, there was a well-condensed central coma with d = 0'.5, and there was a very faint outer coma with D = 1'.5.

A large series of visual observations of the comet total brightness, the brightness of the nucleus, and the dimensions of the coma and tail was cited by M. Beyer (Hamburg-Bergedorf) in the reference AN, Vol. 291, 1969, pp. 6, 261, along with the photoelectric determinations by K. Wenske. Seventy-four observations of the comet integral brightness during the period from July 7 through November 14, 1968, were studied by Beyer. In the second half of July, the comet brightness increased with oscillations from 7.5 to $7^m.0$; Towards the end of August, the increase in the comet brightness continued to $6^m.0$; in the first ten days of September, m oscillated near $6^m.0$, and towards the end of September, a fall in brightness is noted to $7^m.5$. In the second half of October, m = $8^m.6$ — $9^m.3$. On November 4.7, according the Beyer, m = $9^m.9$; on November 14.7, the comet was fainter than $10^m.0$. Estimates of the brightness of the nucleus during the first period of observation was h = $11^m.0$ — $12^m.5$ and D ~ 4 — 9'. In August, h = 11^m — $11^m.5$ and D ~4 — 8' (according to Wenske, 11 — 18'). In September, h = 11 — 12^m and D ~ 8 — 6'. The maximum observed length of the tail was about 30' (according to Wenske, 60') with rays near the direction of the radius-vector extended. Rises in the comet brightnes were noted during a two- /59
hour period on August 22.9, and on September 9.8 and 11.8, significant variations occured in the nature and brightness of the nucleus.

On October 27, E. Roemer photographed the comet as an almost stellar object of 15^m. The last determination of its position was made by T. Urata (Shimizu, Japan) on November 10, 1968.

Literature. IC, Nos. 2082 — 2134; KTs, Nos. 71 — 79; Sky and Telescope, Vol. 36, Nos. 2 and 3; Quart. Journ. RAS, Vol. 10, No. 3, 1969; AN, Vol. 291, No. 6, 1969.

The initial orbits were calculated by Ts. Seki and B. Marsden (IC, Nos. 2087, 2089, and 2092; KTs, No. 72). The orbit was by B. Marsden (IC, No. 2127; KTs, No. 79); T = August 7.908, 1968, i = 143°24, q = 1.16036 a.u.; a parabola with reverse motion.

The preliminary estimates of the value of the comet absolute magnitude were made by Marsden for the calculation of the photometric ephermeris; it was taken as $H_{10} = 5^m.5$ and $6^m.0$ (IC, Nos. 2087 and 2089; KTs, No. 72). On the basis of numerous estimates of the comet integral brightness using fast observing equipment (without M. Beyer's observations), we find $H_{10} = 5^m.3 \pm 0^m.1$ (30 observations); the law y = 10 agrees well with the comet brightness curve. Significant rises in brightness were noted at the end of July and the beginning of August, at the end of August, and in the middle ten days of September.

M. Beyer found, from 74 estimates (his own and those of K. Wenske), the photometric parameters y = 9.95 ± 0.5, $H_y = 5^m.78 \pm 0^m.05$, which correspond to $H_{10} = 5^m.7$. Thus, the comet absolute magnitude was determined very certainly; a divergence of $0^m.4$ between M. Beyer's value and ours can be explained by the less favorable, in the sense of transparency, observational conditions at Bergedorf in comparison with the American observers who used faster instruments.

$D_1 = 6' — 9'.9$ (Beyer); the maximum tail length was S = 0.041 a.u. (August 29, K = 57°). The tail was of a complex nature with Type I streamers. A grating spectrum of the comet was taken by V. Shevchenko (Dushanbe) with the reflector of the southern station of the Schternberg Astronomical Institute; the usual emissions and the strong continuous spectrum were noted in the spectrum. P. Osherov and N. Kiselev measured the degree of polarization in the comet and found P = 0.06 — 0.23 in July and August, and P = 0.06 — 0.38 in September.

r and Δ: July 7, 1968 — 1.27, 2.09; July 20 — 1.20, 1.74; July 31 — 1.17, 1.44; August 7 — 1.16, 1.25; August 17 — 1.17, 0.97; August 27 — 1.20, 0.75; September 9 — 1.27, 0.66; September 21 — 1.35, 0.86; October 11 — 1.53, 1.44; October 31 — 1.73, 2.06; and November 20 — 1.95, 2.61.

1968 VII — 1968d

This comet was discovered by the amateurs D. Bally-Urban (Richmond, California) and P. Kleyton (Springfield, Missouri) on August 24.3, 1968, during the Southwestern Astronomical Conference at Las Cruces, New Mexico.

According to an estimate by J. Young, on the night of discovery and on August 25.1, the comet was diffuse without a central condensation or nucleus, and $m = 11^m$. It was found in Lyra /60
and moved towards the southwest. In September, it entered Hercules, where it slowly shifted westward during the entire period of visibility (September — November).

In the course of a position determination on August 25.9, Lokher (Vettsikon, Switzerland) estimated the comet brightness to be 12^m, and Waterfield (Woolston, England) — 10^m. On August 25 — 26, a diffuseness was noted as well as a central condensation, and a bulge in the direction of motion (Young, Waterfield, Milan). On August 27.8 and 28.8, N. S. Chernykh (Krimean Astrophysical Observatory) estimated the comet brightness to be 11^m and the coma diameter to be 1', and he noted a distinct central condensation. According to the observations of E. Roemer and Schreur on August 27, the comet had insignificant traces of a coma and an almost stellar nucleus of $15^m.2$. On August 27, Bortle estimated $m = 10^m.4$ and $h = 12^m.5$ for the nucleus. On August 28, he noted a tail 6 .n length in the direction of position angle

130°. On August 31, Waterfield found m = $10^m.5$. On September 2, E. Roemer and Kh. Raudsaar photographed the comet. On September 9, according to Waterfield, the comet brightness was 11^m. On September 11, M. Beyer noted a tail 6' in length (p ~ 188°), but he did not see it subsequently. On September 12, Van Biesbroeck photographed the comet. On this same night, Young and Denman, using a 24-inch telescope, observed visually in the course of an increase by a factor of 1625 a second nucleus at a distance of 4" (p = 290°). The components had visual magnitudes 14^m and 12^m. On September 14, 21, and 25, the comet was measured at Washington (Miranyan). On September 15, it was observed at the Krimean Astrophysical Observatory (Chernykh), on September 16 and 17 — in Rumania (Cristesku, Bucharest Observatory), and on September 19 — 20 — at the Krimean Astrophysical Observatory, Tartu, and at the Catalina station (Van Biesbroeck). On September 29, Bortle estimated m = 12^m or a bit brighter. According to Beyer, the comet faded starting August 29 (m = $10^m.1$) and had $10^m.8$ on September 21, $11^m.5$ on October 18, and $12^m.3$ on November 14. On October 19, E. Roemer obtained a not completely stellar nucleus of 17^m with traces of a coma. On November 24, there was a distinctly condensed nucleus of h = $16^m.6$ and a circular coma with D = 0'.6. In the Krimea, at the Schternberg Astronomical Institute souther station, the comet was observed on October 24 using the 50-cm Maksutova telescope. Ts. Seki observed the comet on April 7.6, 1969, 5°.5 from the pole with m = 16^m.

Literature. IC, Nos. 2092 — 2118 and 2141; KTs, Nos. 72 — 78; Quart. Journ. RAS, Vol. 10, No. 3, 1969, p. 247; AN, Vol. 291, No. 6, 1969, p. 254.

The initial orbits were calculated by B. Marsden, N. Bokhan, and G. Kastel' (IC, No. 2095; KTs, Nos. 73 — 75) and are rather similar to one another.

The orbit was by B. Marsden (IC, No. 2097); T = August 20.92, 1968, q = 1.7716, i = 93°11.

The preliminary values were $H_{10} = 8^m.0$ (Marsden), $8^m.4$ (Bokhan) and $8^m.0$ (Kastel').

We obtained, from the 13 high estimates of the integral brightness during the period from August 24 through November 14, $H_{10} = 8^m.0 \pm 0^m.14$, $h_{10} = 10^m.3$. A rise in brightness was noted at the end of September.

M. Beyer obtained, from his own 17 observations, the photometric parameters y = 6.22, $H_y = 8.08$. This result corresponds to $H_{10} = 7^m.3$. Based on Beyer's observations, $D_1 = 4'.0$ and S = 0.0054 a.u. for the end of August and the beginning of September, when the phase angle K lay within the limits 23 — 27°. /61

r and Δ: August 24, 1968 — 1.77, 0.98; September 6 — 1.78, 1.26; September 16 — 1.80, 1.44; September 21 — 1.82, 1.55; October 11 — 1.89, 1.90; October 31 — 1.99, 2.20; November 20 — 2.12, 2.42; December 10 — 2.26; 2.56; January 19, 1969 — 2.58, 2.70; February 28 — 2.93, 2.84; March 30 — 3.20, 3.09; and April 29 — 3.48, 3.49.

1968 VIII — 1968h

This was the fifth observed apparition of the periodic comet Perrine-Mrkos (1896 VIII — 1962 I). The advance calculation of this short-period comet was done by G. Sitarskiy (Warsaw) on the basis of observations in 1955 and 1961 — 1962. B. Marsden obtained a very similar ephermeris for 1968, and, using the data of the 1896 and 1909 apparitions, he attempted to take into account the effect of nongravitational forces. Starting from the

month of June, searches for the comet were made near Tucson (Catalina station) and at stations of the Tokyo Observatory, but they did not give results for a long time. The well-known comet observer, Mile (Nice), announced the rediscovery of the comet by him on a plate taken November 12, but no objects brighter than 19^m were apparent on the plates taken by Roemer on October 19 and November 23, covering this same region. Only at the beginning of December was the conclusive discovery of the comet announced: it was found on plates taken November 20.3, 21.1, and 22.4 by G. Tamman (122-cm Schmidt telescope of the Palomar Observatory) more than 2° from each of the predicted ephermeridies but closest of all to the advance calculation of G. Sitarskiy. The comet gave diffuse but condensed images of 15 — 16^m.

In connection with the events associated with the advance calculations of short-period comets which, it would appear, are well studied with respect to their motion, B. Marsden emphasized the decisive significance of nongravitational effects, which cause, in a number of cases, very significant deviations from the rigorous purely gravitational theory of cometary motion. One may recall that S. K. Vsekhsvyatskiy already, in 1933, and then in 1950 (Aston. zh., Vol. 10, 1933, p. 18; Vol. 27, 1950, pp. 23 — 25 ; Vol. 29, 1952, p. 63), pointed out (with the necessary calculations) with all determinacy to this circumstance flowing out of the entire history of advance calculations of periodic comets. The example of Comet Perrine-Mrkos, together with other well-known facts, clearly points out the complete untenability of the idea that it is possible to solve the problem of the origin of comets by means of advance calculations for lengthy periods of time in the future or the past (if one takes into account only gravitational effects). Only the case of a special investigation of nongravitational forces (reactive effects of the gases sublimating from the surface of the cometary nucleus, deceleration

caused by the interplanetary medium, the characteristic features of which vary significantly during different periods of solar activity and as a result of active processes on the planet; the effect of interplanetary magnetic fields, and so on), in the case of a special stability, or in the case of significant masses of /62
cometary nuclei is it possible to be certain in the reality of such advance calculations. Very significant discrepancies between theory and reality can, upon significant encounters of the comet with massive planets, result in a radical discrepancy of the actual motion of comets from the advance calculations. The detailed calculations of U. Leverrier of all the circumstances of the motion of Comet Lexell 1770 I already indicated this long ago.

After the rediscovery of the comet, G. Tamman and K. Tomita found its image on plates taken already on November 16 — 17 (at this time $m = 15 — 16^m$), as did Ts. Seki on a plate taken October 24 ($m = 17^m$). The comet was observed in December by Tamman and Seki. The latter noted $m = 12^m$ for December 15. Also, E. Roemer at the Catalina station, T. Urata at Tokyo Observatory, and K. Cesco and A. Samuel at the Yale-Columbia southern station photographed the comet. On December 23, Roemer obtained, even under poor visibility, a condensed nucleus of 16^m in a faint coma about 0'.5 in diameter. On December 17.5, G. Tamman noted a distinct central condensation and a halo 2' in diameter.

On January 13.6 and 14.6, 1966, Seki obtained $m = 16^m$ with a 22/110-cm camera.

Literature. IC, Nos. 2064 — 2132; KTs, Nos. 69 — 77; Quart. Journ. RAS, Vol. 10, No. 3, 1969, p. 248.

The orbit was by G. Citarskiy (IC, No. 2064).

The preliminary values of the photometric parameters were $y = 15$, $H_\mu = 12^m.0$ (Milbourn and Lea) and $y = 15$, $H_y = 15^m.0$ (Marsden).

Based on the cited estimates with a correction of $-2^m.5$ to E. Roemer's observations, we obtained $H_{10} = 15^m.6$ on the average. In October — November of 1968, the comet was very faint in the absolute sense ($H_{10} \sim 17^m$), but in December, it increased in brightness by almost 4^m, and in January, it had $H_{10} \sim 15^m.0$ and $D_1 = 0'.9$ (December 17).

r and Δ: October 11, 1968 — 1.31, 0.41; October 31 — 1.27, 0.32; November 20 — 1.29, 0.31; December 10 — 1.36, 0.39; December 30 — 1.45, 0.53; and January 19, 1969 — 1.58, 0.72.

1968 IX — 1968e

This comet was discovered on August 30.8, 1968, by the well-known comet seeker M. Honda (Kurashiki, Japan) and was the twelfth new comet discovered by him. It appeared diffuse, of 10^m, and without a condensation. It was found in Monoceros ($\alpha = 6^h0^m.2$, $\delta = 6°40'$) and rapidly shifted south 1.5 — 2° per day near the 6^h hour circle. In September, it passed through Canis Major and Puppis, and on October 16, it was 12° from the south pole, after which it shifted northward between 16^h — 18^h of right ascension: at the end of November, in was in Scorpius, moving towards the constellation Sagittarius.

It was independently discovered by N. Ito on September 22.8 (Hachinohe, Japan), who estimated $m = 8^m$. On September 4, it was observed by K. Simmons (Jacksonville, Florida) and had $m = 9^m.7$ and a central condensation. Matchett (Queensland) found $m = 10^m$ on September 3.8. Starting from September 5, it was /63

observed at the Smithsonian Astrophysical Observatory stations in Australia, Hawaii, South Africa, Brazil, and Argentina. On September 5.6, m = 10^m (Hawaii), 16.8 — 9^m (Australia), 17.3 — 7^m (Argentina), 18.0 — 7^m (South Africa), 18.25 — 10^m (Brazil, 19.1 — 7^m (South Africa), and 19.3 — 6^m (Argentina).

Accurate positions were determined by Ts. Seki, Van Biesbroeck, and K. Tomita on September 8 — 18, which permitted B. Marsden to determine the first orbit (q = 1.10 a.u., T = November 3.8, 1968, i = 128°).

On September 22.4 and 23.4, K. Simmons estimated m = $7^m.8$, h = $12^m.4$, and D = 4', in the case of a low position for the comet and noted a tail 1'.5 in length (p ~ 180°) and a thin ray 5' in length (p ~ 270°). On September 29.04, P[illegible]ong at Johannesburg (Republic Observatory) determined the po[illegible]n and noted m = 7^m. A series of photometric estimates were ma by A. Jones (Nelson, New Zealand): September 2.7 — $10^m.5$; 10.7 — $10^m.3$; 14.7 — $9^m.2$; 16.7 — $9^m.4$; 17.7 — $8^m.9$; 18.7 — $9^m.7$; 20.7 — $8^m.5$; and 24.7 — $8^m.1$ (traces of a tail). During the lunar eclipse of October 6, Jones obtained m = $7^m.6$. The comet was located at this time at its closest distance to the Earth (Δ = 0.91 a.u.), but it was still almost a month before perihelion.

On October 12, accurate positions were determined from plates taken by Pereyra (Cordoba Observatory), and the comet brightness was estimated to be $8^m.1$; the comet had a very faint tail 7' in length and a coma 3' on the plate taken with the 60-inch reflector at Bosque Alegre. On October 20.98, Pereyra estimated $8^m.6$ and on October 30.0 — $8^m.7$. In November, a decrease in brightness was noted still more definitely; A. Jones gives the following estimates: November 3 — $9^m.5$; and 28 and 30 — 10^m. On December 6.1, it was almost invisible due to its low altitude

and the Moon's presence. The comet should have been accessible to observers of the northern hemisphere, and on March 15, E. Roemer estimated h = $19^m.6$, based on a 30-minute exposure with the 154-cm reflector. On April 19, she noticed the comet as diffuse and of 18 — 19^m, which indicated the rapid fading of the comet.

Literature. IC, Nos. 2094 — 2121 and 2143; KTs, Nos. 73 — 78; Quart. Journ. RAS, Vol. 10, 1969, p. 246.

The preliminary orbit was by B. Marsden based on observations between August 31 and September 18 (IC, No. 2099). The orbit was by B. Marsden, based on 24 observations from September 12 through October 29 (IC, No. 2121).

The preliminary values of the absolute magnitude were used for the photometric ephermeridies: $H_{10} = 7^m.5$; $7^m.0$; and $8^m.0$ (Marsden). Based on the 29 cited observations, the value of the comet absolute magnitude was $H_{10} = 6^m.9 \pm 0.2$. An especially large brightness increase was noted on September 19 — 29, 1968. From the middle of October and in November, the comet faded in absolute brightness by almost $1^m.5$. In March — April of 1969, it faded by 1 — $1^m.5$ more. $D_1 = 2'.8$ (October 12) and S = 0.002 a.u.

The comet spectrum was obtained with an objective prism on a telescope of the European Southern Observatory (La Serena, Chile) by A. Laval and Florsh on September 26 and 29. The presence of emission bands of CN, C_3, C_2 (λ 4730), traces of CH, and a weak continuous spectrum were noted (IC, No. 2101). /64

r and Δ: August 30, 1968 — 1.58, 1.75; September 15 — 1.43, 1.35; September 25 — 1.28, 0.96; October 3 — 1.22, 0.91; October 13 — 1.16, 0.96; October 23 — 1.12, 1.12; November 4 — 1.10, 1.39; November 16 — 1.12, 1.67; November 28 — 1.17, 1.92;

January 19, 1969 — 1.63, 2.45; February 28 — 2.08, 2.27; March 20 — 2.31, 2.09; and April 29 — 2.77, 1.52.

1969 1 — 1968j

This was a new, almost parabolic comet with a large perihelion distance discovered by N. Tomas (Lowell Observatory, Arizona, USA) on a plate exposed on December 19.3, 1968, for the proper motion program. It appeared to be a diffuse but highly condensed object of 13^m. Upon discovery, it was located in Camelopardalis 8° in all from the pole ($\alpha = 5^h23^m$, $\delta = +81°44'$), and at that time, it was at a distance of 3.3 a.u. from the Sun and 2.7 a.u. from the Earth, and a month in all prior to its perihelion passage. It slowly shifted in the southeast direction in Camelopardalis (February — April, 1969), in May — June, it was in Ursa Major, and towards the end of 1969, it descended into the constellation Coma Berenices. The first positions were obtained by C. Giclas, Seki, and Urata. Starting from December 21, it was observed in Japan; Ts. Seki estimated $m = 13^m$ on December 21.2 and 22.5, and T. Urata (Shimizu) estimated $12^m.5$ on December 22.7. Ts. Seki found $m = 12^m.5$ on December 24.6 and $13^m.2$ on December 30.8. On January 15, 1969, Van Biesbroeck observed $m = 12^m$. M. Antal (Skalnate Pleso) noted, on January 8.8, the comet was diffuse with a nucleus $m = 14^m$. At this same time, Water field (Wolston Observatory, England) cited $m = 12^m.5$ and described a highly condensed coma 20" in diameter and a faint outer coma 1' in diameter along with two straight rays from the center of the nebulosity with a length of 2' (p = 100°) and 1'.5 (p = 150°). On January 14.8, Waterfield gave $m = 13^m.0$. Seki's observations were as follows: January 17.6 — 13^m; February 8.5 — 14^m; February 9.6 — 14^m; and February 21.6 — 14^m.

B. Mile (Nice) noted, on February 6.10 and 24, a nucleus with a faint elliptical condensation. On March 7.8, m = $13^m.3$ (Waterfield); 17.1 — $14^m.7$ (Giclas); and 17.5 — 15^m (Seki). On April 4.9, 7.9, and 8.9, Waterfield estimated m = $13^m.8$. On April 20.18, E. Roemer gave m = $17^m.5$, evidently the central condensation, and on May 19.0, according to Waterfield, $14^m.5$ and an outer coma 1'.0 in diameter of a central condensation 20", and a straight ray extended out from the coma center by 3'.0 (p = 0°). On April 20, 1969, E. Roemer estimated h = $17^m.4$, and on May 12, $18^m.4$. Also, based on observations with the 154-cm Catalina reflector, she found h = $17^m.4$ on June 23. On January 5, 1970, the comet was easily visible (Roemer) with the 229-cm reflector. On February 8, it was a well-condensed image of $17^m.5$ — $18^m.0$ (154-cm reflector). On March 7, m_2 = $18^m.0$, on April 6, $18^m.3$ with traces of a coma, on May 3, $18^m.7$, and on June 1, h = $19^m.6$ (60-minute exposure). On July 5, 1970, $19^m.3$, and the image was still highly condensed.

Literature. IC, Nos. 2122 — 2170; Quart. Journ. RAS, Vol. 10, No. 3, 1969. /65

The initial orbits were calculated by L. Cunningham (Leushner Observatory, Berkeley), Ts. Seki, and B. Marsden (IC, No. 2128 and No. 2135). B. Marsden (IC, No. 2146) determined a third elliptical orbit based on 41 observations from December 19, 1968, through April 20, 1969: T = January 12.16, 1969, q = 3.32, and P ≈ 18,000 years.

Marsden cited preliminary values of H_{10} = $9^m.5$ for the central condensation and H_{10} = $6^m.5$ for the integral brightness. We obtain, on the basis of the cited 26 brightness estimates, H_{10} = $5^m.8 \pm 0^m.13$, mainly for the period after perihelion. D_1=2'.7-3'.8. For the rays, evidently of Type I, S= 0.012 a.u.; a phase angle was K=17°.

r and Δ: December 19.0, 1968 — 3.31, 2.66; January 19, 1969 — 3.32, 2.78; February 18 — 3.33, 2.88; March 20 — 3.38, 3.19; April 19 — 3.44, 3.40; May 19 — 3.52, 3.84; June 18 — 3.63, 4.18; July 18 — 3.75, 4.50; October 26 — 4.24, 4.88; December 25 — 4.58, 4.49; February 23, 1970 — 4.95, 4.11; April 4 — 5.20, 4.29; and May 14 — 5.46, 4.91.

1969 II — 1970p

This comet was discovered by J. Gunn upon inspection of a plate taken with the 122-cm Schmidt telescope of the Palomar Observatory on October 27.225, 1970. The comet was located in Cetus, and it was diffuse with a central condensation and a small tail. Its total brightness was 16 — 15^m, and it was slowly moving with retrograde motion parallel to the eccliptic. On November 22 and 23, it was discovered on plates of the Palomar Schmidt telescope taken by J. Bakall, and later it was also found on three plates of the 61-cm reflector at Table Mountain Observatory (California) taken by J. Young. On the basis of the first observations, a preliminary short-period orbit was found by Marsden, which showed that the comet has passed perihelion already a year and a half prior to its discovery, which gives a revolution period close to seven years. On the basis of subsequent observations of Kristian (Mount Palomar), including that of January 2.2, 1971, when $m_1 = 17^m$, Marsden found the following approximation to the orbit. It turned out that Comet Gunn should have, at the end of June, 1969, been situated near $\alpha = 19^h.3$ and $\delta = 33°$, and had an integral brightness no fainter than 12^m. In September of 1965, a close approach with Jupiter should have occurred (or a departure from Jupiter's system).

On January 21, 1971, E. Roemer and L. Gonsales observed the comet with the 229-cm telescope of Kitt Peak and found $m_2 = 19^m.5$. Based on a three-month arc, B. Marsden calculated a third orbit for the new short-period comet. Subsequent observations were obtained by Roemer on February 28.12 ($m_2 = 18^m.8$) and March 3.12 (with the 229-cm Kitt Peak telescope).

Literature. IC, Nos. 2294 — 2329; KTs, Nos. 112 — 119.

B. Marsden gave $H_{10} = 8^m.0$ for the comet absolute magnitude on the basis of the first observations and $h_{10} \sim 10^m$, $D_1 \sim 1'$, $S = 0.0005$ a.u. (?). The orbit was by B. Marsden (IC, No. 2322), /66 according to which T = April 19.0, 1969 and P = 6.80 years.

r and Δ: February 28, 1969 — 2.44, 2.61; April 9 — 2.41, 2.11; May 19 — 2.41, 1.67; June 28 — 2.44, 1.44; August 7 — 2.49, 1.58; September 16 — 2.56, 2.02; October 26 — 2.65, 2.60; November 11, 1970 — 3.83, 3.40; December 20 — 3.92, 3.50; January 29, 1971 — 4.03, 4.21; March 30 — 4.15, 5.00; June 18 — 4.31, 5.14; July 28 — 4.38, 4.78; September 6 — 4.45, 4.25; and October 16 — 4.51, 3.75.

1969 III — 1968i

This was short-period Comet Harrington-Abell (1954 XIII, 1962 II) in its third return. It was discovered by E. Roemer on a plate taken November 23.3, 1968, with the Catalina reflector. It was described by Roemer as a well-condensed object of $19^m.4$. Later, Roemer found an image of the comet ($m = 20^m.5$) on a plate taken already on October 27, but she could not detect the comet on a plate of October 17, although it showed stars as faint as 20^m.

Upon its rediscovery in October — November, the comet was located in the constellation Eridanus ($\alpha = 3^h24^m$, $\delta = +10°33'$ for November 23). From the start of 1969, moving northeastward, it should have been located in March — April in a position in Taurus-Orion very favorable to northern observers. It was observed by E. Roemer on February 16 to be well condensed with barely noticeable traces of a coma with $h = 19^m.8$ — $20^m.0$ (154-cm Catalina reflector). On April 19 and 20, the comet appeared as a faint diffuse spot of $18^m.5$ — $19^m.6$ on a 50-minute exposure.

Literature. IC, Nos. 2102 and 2115; KTs, Nos. 76 and 77; PASP, Nos. 480 and 481; Quart. Journ. RAS, Vol. 10, No. 3, 1969, p. 1; I. Hasegawa, Catalogue of Periodic Comets, 1968.

The orbit was determined in advanced by B. Marsden on the basis of 19 observations of 1955 and 1962, taking into account perturbations (IC, No. 2102); T = May 10.82, 1969, q = 1.773, and P = 7.192 years.

B. Marsden emphasized the importance of observations of this comet, which should, about the beginning of 1973, pass at a very close distance to Jupiter ($\Delta \sim 0.04$ a.u.) and may be lost as a result of the very large perturbations if it is impossible to clarify the influence of nongravitational effects on its motion.

Preliminary values of the photometric parameters were $y = 15$ and $H_y = 13^m.5$ (Marsden). Based on estimates of E. Roemer (with a correction of $-1^m.0$), $H_{10} = 14^m.3 \pm 0^m.3$. If one does not introduce a correction into the estimate, we obtain $H_{10} = 15^m.3$ for comparison with the 1955 and 1962 apparitions, i.e., practically the same value as at the past apparitions.

r and Δ: October 31, 1968 — 2.44, 1.53; November 20 — 2.34, 1.43; December 10 — 2.23, 1.42; January 19, 1969 — 2.05, 1.57; February 28 — 1.89, 1.81; April 9 — 1.80, 2.06; May 19 — 1.78, 2.31; June 28 — 1.83, 2.58.

1969 IV — 1969h

This was a new short-period comet discovered at Kiev on October 23 on five plates taken in September of 1969 by the /68
expedition of the astronomy faculty of Kiev University with the Maksutov meniscus 50-cm telescope of Alma-Ata Observatory of the Institute of Astrophysics of the Tajicston SSR Academy of Sciences. It was found by K. I. Churyumov in the course of searches on negatives from September 9.9 and 11.9 of Comet Comas-Sola, for which the telescope was guided by S. I. Gerasimenko in agreement with the ephermeris data for this short-period comet. The new comet appeared at a distance of 2° below Comet Comas-Sola and with approximately similar diurnal motion ($\alpha = 7^h03^m$, $\delta = +23°49'$). The comet was almost completely unshifted on the plates, and it possessed a noticeable coma and the characteristics of a faint broad tail in the direction p = 280° (Figure 14). The new comet was noticeably brighter (by $1^m.5$ — 2^m) than Comet Comas-Sola, although it was located at the edge of the plates. On September 9 and 11, $m = 13^m$; on September 21.93 and 21.95, $m = 12^m$; the diameter of the central condensation was 0'.3, that of the faint outer coma was 0'.6, and the tail was about 1' in length.

At first, approximate, and then accurate, positions of the new comet were communicated to the Institute of Theoretical Astronomy and to the International Center (Cambridge, Smithsonian Observatory, B. Marsden), and this permitted calculating preliminary orbits and carrying out searches for the comet on plates where the corresponding region was exposed. Already at the end

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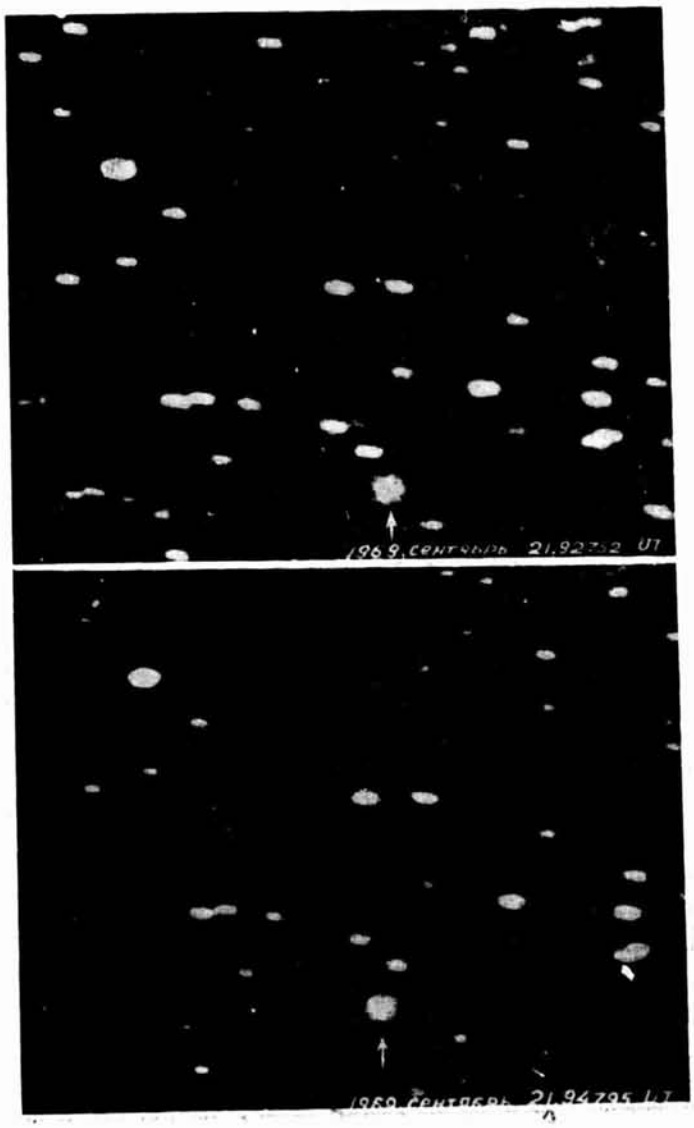

Figure 14. Comet Churyumov-Gerasimenko 1969 IV. Photographed by K. I. Churyumov, September 21.92752 and 21.94795, 1969 UT, with the 50-cm meniscus telescope of the Alma-Ata Observatory, 20-minute exposure.

of October, the comet with a narrow tail 10' in length (p = 290°) was detected by J. Bortle on a negative taken by the amateur astronomer K. Skovill (Stamford, Connecticut) on September 14.37, who also photographed the comet on October 31.38 and 31.40 and

estimated m = 14^m. It was detected by B. Mile on a plate of September 13. A preliminary parabolic orbit was calculated by M. Ya. Shmakova, and six orbits — three parabolic and three elliptical — were calculated by B. Marsden.

On the basis of these ephermeridies, the corresponding region in Lew where the comet was found were photographed with the large metric Schmidt telescope of the Byurakan Observatory on the night from November 13 — 14 (the telescope at this time was operating with a two-degree prism) and on the night of November 15 — 16 (the observer was V. Lipovetskiy). The comet was detected as a completely noticeable object with a nebular spectrum and noticeable characteristics of a tail up to 3' in length. On the basis of S. K. Vsekhsvyatskiy's estimate, m = 12 — $12^m.5$. The comet was detected also on plates of the double astrograph of the Byurakan Observatory (15/150-cm, observer — B. Afanas'ev).

Beginning from the night of November 17 — 18, the comet was observed by S. K. Vsekhsvyatskiy with the 50-cm Schmidt telescope of Byurakan Observatory; the comet gave sharp images, even with exposures on the order of 5 minutes. On the basis of measurements and estimates from the plates, the following information was garnered: November 18.04 — sharp central condensation of m = 13 — 14^m, faint coma about 0'.8; November 19.08 — m = 12 — 13^m, D ~ 1', and a tail with C = 2'; November 20.06 and 20.08 — a sharp condensation noncentrally situated in the coma, m = 12^m, D = 1', C ~ 4' (p = 286°), the tail was straight and thin; November 22.10 — a nuclear condensation with h = 13 to 14^m.

Figure 15. Comet Churyumov-Gerasimenko 1969 IV. Photograph taken by Elizabeth Roemer with the 229-cm reflector of the Steward Observatory (Kitt Peak), November 5, 1969.

Based on the observations of Ts. Seki, m = 14^m on November 1.83, and 14^m on November 4.80. According to the estimate of N. S. Chernykh (Krimean Astrophysical Observatory, 40-cm astrograph), the comet brightness was 14^m on November 8.04. It was diffuse with a central condensation and a tail <1°. Based on the estimates of Vsekhsvyatskiy, Afanas'ev, and Gerasimenko, its brightness was $14^m.3$ on November 15.08 and 13^m on November 17.10. Van Biesbroeck, using the 154-cm reflector of the Catalina station, found m = 14^m, D = 1', and h = 17^m on December 8.46. The comet was observed in January — March by A. Mrkos (Klet' Observatory), N. Candy, Ts. Seki, and B. Mile. E. Romer, using the 229-cm Steward telescope, took a 10-minute exposure on November 5 (Figure 15) on which a faint trace of a tail 2'.5 in length (p = 220°) is visible from the comet starlike nucleus (h = $17^m.0$); on November 13, K. Scovill photographed a tail 5' in length (p = 300°). /69

Subsequent observations by Roemer were as follows: on January 5, 1970, h = $16^m.8$; February 3 — $17^m.2$. Traces of faint structure were visible out to 0'.2 (p = 100° and 200°).The comet faded from February of 1970 and was already not possible to observe with medium-sized telescopes. On March 7, it was visible with difficulty as a faint diffuse spot using the 154-cm reflector (16^m ?). On a pair of plates of 30-minute exposure, a condensed image with h = $18^m.2$ stood out sharply. On May 3, it was photographed with the 154-cm telescope (60-minute exposure), but it did not appear on the plate. On May 8, 1970, distinct but faint images of a comet of $21^m.0$ were found on a pair of 60-minute exposures taken with the 229-cm reflector.

The photovisual (V) and photographic magnitudes of Comet 1969n were determined at Kiev on numerous negatives taken at Alma-Ata, Abastumani, and Byurakhan. The results of these determinations are cited below.

Literature. IC, Nos. 2179 — 2187, 2195, 2201, 2209, 2224, 2312, and 2328; KTs, Nos. 90 — 105, 116, and 118; and PASP, Nos. 484 and 485.

Preliminary orbits were calculated by M. Ya. Shmakova (KTs, No. 90) and B. Marsden (IC, No. 2180 and KTs, No. 91).

An elliptical orbit was calculated by B. Marsden (IC, Nos. 2180, 2187, and 2201; and KTs, No. 91) and the orbit computered by N. A. Belyaev gave T = September 11.058, 1969, q = 1.285 and P = 6.553 years. The most probable orbit, on the basis of all the published observations, was calculated by N. A. Belyaev (Institute of Theoretical Astronomy). The comet motion prior to its discovery was investigated. On February 4.48, 1959, a very close approach of the comet to Jupiter took place (to within 0.05 a.u.).

The preliminary values of the absolute magnitude were H_{10} = $10^m.5$ (Shmakova) and $11^m.0$ (Marsden). Using the estimates known prior to December 1, we obtained $H_{10} = 10^m.4 \pm 0^m.3$. For the central condensation, $h_{10} = 11^m.1$, $D_1 = 1.3$, and S = 0.004 a.u. (September 14, 1969). /70

r and Δ: August 7, 1969 — 1.35, 1.52; August 27 — 1.30, 1.43; September 6 — 1.29, 1.40; September 16 — 1.29, 1.38; September 26 — 1.30, 1.37; October 16 — 1.35, 1.36; November 5 — 1.44, 1.34; November 25 — 1.56, 1.30; December 15 — 1.70, 1.25; January 4, 1970 — 1.84, 1.19; February 3 — 2.06, 1.16; February 23 — 2.21, 1.23; March 15 — 2.36, 1.41; April 4 — 2.50, 1.68; April 24 — 2.65, 2.02; May 14 — 2.79, 2.41; June 3 — 2.92, 2.81.

1969 V — 1969e

This was the fourth observed return of the short-period comet Honda-Mrkos-Pajdushakova, which was first discovered by Japanese and Czechoslovakian comet seekers in 1948 (1948 XII, 1954 III, and 1964 VII; the 1959 return was missed). It was rediscovered by A. Mrkos (Klet' Observervatory, Czechoslovakia) on August 12.06 at the position $\alpha = 3^h.38^m$, $\delta = +69°10'$ at a distance 6' from the point based on Marsden's ephermeris.

Upon discovery, it was characterized as diffuse, without a condensation, and $m = 14^m$ and D = 3 — 5'. It was moving in the constellation Cassiopeia about 3° per day. It passed through Camelopardalis, at the end of August it was in Lynx, in September and October it crossed Leo and Cancer, dropping southward, and in November it was in Virgo and Corvus.

After its discovery, Seki found a 15^m image of the comet on a plate exposed on August 11.78. Subsequent observations were as follows: on August 15.90, m = 14^m (mrkos); 12.70 — 15^m; 13.75 — $14^m.5$ (Kojima, Ishiki); 20.11 — 13^m (Wild) — diffuse with a faint condensation; and 23.8 — 13^m (Seki). On September 2.82, according to Seki's observations, it increased in brightness by 4^m (m = 9^m) and appeared diffuse without a condensation. On September 9.11, on a photograph taken by Mrkos with a 42-cm f/2 Maksutov camera, m = $14^m.1$. In September, Mile (Nice) determined its position, not remarking on the comet significant brightness. However, on September 20.17, Morgan and Waterfield estimated m = $8^m.5$.

According to the observations of J. Bortle and K. Scovill (USA), it was easily visible on September 10 in 50 x 16 binoculars, and it remained bright (m ~ $8^m.3$ and D ~ 2') right up until September 21. The tail on photographs taken September 12 — 14 were 16 — 21' in length and straight and narrow. Several times a nucleus with d = 6" was noticed. At the beginning of October, Ts. Seki again estimated the comet to be very bright. On October 1.8 — 9^m; October 10.8 — 10^m; and on October 12.8 — 11^m. Evidently the strong brightness outburst, which were repeated every 25 — 30 days, corresponded approximately to the synodic revolution of the Sun with respect to the comet and, consequently, to the effects of one or another axis region of the Sun. On October 11, according to E. Roemer's observations, a distinct condensation of $15^m.8$ was surrounded by a faint symmetrical coma. /71

Literature. IC, Nos. 2145, 2162 — 2179; KTs, Nos. 85, 87, and 89; and PASP, Nos. 483 and 484.

The orbit was by B. Marsden and, based on observations from 1948 — 1949, 1954, and 1964, taking into account nongravitational forces and perturbations from all nine planets (IC, No. 2146); T = September 23.005, 1969, q = 0.559, and P = 5.218 years.

B. Marsden used the parameters y = 15 and $H_y = 17^m.5$ for the photometric ephermeris, having the central condensation in mind. These data appeared to be completely at variance with reality.

We get $H_{10} = 15^m.0 \pm 0^m.8$ from all the cited estimates.

On the basis of Ts. Seki's high estimates, the absolute magnitude at the moments of the outbursts were $H_{10} = 11^m.6$, $D_1 = 1'.2$, and S = 0.003 a.u. (September 14).

r and Δ: August 7, 1968 — 1.05, 0.31; August 17 — 0.91, 0.31; August 27 — 0.78, 0.39; September 6 — 0.66, 0.53; September 16 — 0.58, 0.71; September 26 — 0.56, 0.91; October 6 — 0.62, 1.11; October 16 — 0.72, 1.28; October 26 — 0.86, 1.43; and November 15 — 1.13, 1.66.

1969 VI — 1969a

In its sixteenth observed return, Comet Faye (1843 III — 1962 VII) was discovered by E. Roemer on May 17.46 at the position $\alpha = 23^h39^m$, $\delta = +3°58'$, near the ephermeris of F. B. Khanina and N. A. Belyaev. The comet was diffuse and had a central condensation, a small narrow tail (0'.3 to the southwest), and a brightness of $m = 18^m$. On June 13 and 23, on photographs taken by E. Roemer, a nuclear condensation with $h = 17^m.4$ was visible with traces of a tail to the west.

In July and August, it was photographed by A. Mrkos and Petrovicheva at the Klet' Observatory in order to determine accurate position. Based on the observations of Ts. Seki (Kochi Observatory), m = 14^m on August 8.77, 14^m on August 9.80, and $13^m.5$ on August 12.71. B. Mile (Nice) photographed the comet on September 6 as diffuse without a nucleus; on September 10.4, Van Biesbroeck observed the comet. On September 14 and 19, J. Bortle and K. Scovill photographed the comet and found D = 1', a central condensation 0.3 in size, and a tail 8 — 9' in length. On September 21, it was nicely visible with a 55-cm telescope; the tail was 10 — 15' in length with a width of 2' (to the west), D ~ 5', and m = $11^m.6$.

In September, K. I. Churyumov and S. I. Gerasimenko (expedition of the Astronomy Faculty of Kiev State University) with the 50-cm Maksutov telescope of the Alma-Ata Observatory, observed m = 12 — 13^m and a small tail 2 — 3' in length. According to Mile, C = 2' on September 22.

On the basis of the data of the IC, KTs, the ALPO bulletin (Milon), and communications of E. Roemer, the following summary is presented of brightness estimates of the comet and the dimensions of the head and tail (Table 2).

E. Roemer detected the comet with difficulty on February 7, 1970, on plates taken with the 154-cm reflector (Catalina station), h = $17^m.5$. However, in February and March, the comet was still rather bright and was observed by Seki and also Mrkos and Petrovicheva (Klet' Observatory), and in Australia by Candy (Perth Observatory). Roemer saw the comet on March 8 as a faint diffuse spot (154-cm reflector), but there was a sharply condensed nucleus of $17^m.8$ with traces of a coma on plates taken with a 30-minute exposure. /72

TABLE 2

Date	Observer	m_1	h	D	C
October 9.05	Mile	-	15^m	0'.8	-
11.80	Seki	12^m	-	-	-
14.17	Mile	13(nucleus)	-	-	2'
17.02	Antal	12.5	-	-	-
18.01	Antal	12.5	-	-	-
16 — 19	Rims, Jones, and Holmes	-	-	1'	3 — 4'
22 — 82	Seki	11^m	-	-	-
November 6 — 15	Rims, Jones	11.5 — 12.2	13.0	3	12 (Nov. 7.4)
5.02	Waterfield	11.5	-	0.5	-
14.99	Burnasheva	13	-	-	-
15.01	Burnasheva	14	-	0.5	1.5
15.76	Seki	12	-	-	-
December 2.51	Jones	12.9(vis)	-	-	-
4.22	Farrar	11.5(vis)	-	-	-
6.2	Bortle	11.6(vis)	13	0.5	-
17.3	Bortle	11.4	-	0.5	-

Literature. IC, Nos. 2162, 2133, 2145 — 2182, 2192, 2196, 2115, 2225, 2240, and 2327; KTs, Nos. 79, 93, 92, 94, 96, 98, and 116; Sky and Telescope, Vol. 38, No. 6; PASP, Nos. 481, 485, and 487; and ALPO Bulletin (Milon).

The ephemeris was by F. B. Khanina and N. A. Belyaev (IC, No. 2062; KTs, No. 116; and BAAH, 1969); T = October 7.670, 1969, q = 1.616, and P = 7.40 years.

The preliminary value of the absolute magnitude was H_{10} = $11^m.1$ (Khanina and Belyaev). From the estimates of Ts. Seki and E. Roemer and observations at Alma-Ata and Byurakhan, we obtain

$H_{10} = 10^m.8 \pm 0^m.2$. For the period of October — December, $H_{10} = 10^m.4 \pm 0.2$, $h_{10} = 12^m.8$, and $D_1 = 2'.3$ (November 7); S = 0.0063 a.u. (the phase angle was K = 24°.8 on November 7, 1969).

r and Δ: May 9, 1969 — 2.18, 2.58; May 29 — 2.06, 2.29; June 18 — 1.96, 2.01: July 8 — 1.86, 1.74; July 28 — 1.77, 1.50; August 17 — 1.70, 1.29; September 6 — 1.65, 1.10; September 26 — 1.62, 0.95; October 26 — 1.63, 0.80; November 25 — 1.69, 0.74; December 25 — 1.80, 0.85; January 24, 1970 — 1.94, 1.13; February 23 — 2.10, 1.53; and March 25 — 2.28, 2.02.

1969 VII — 1969d

This new comet was discovered in Taurus ($\alpha = 5^h43^m.0$, $\delta = +19°00'$) by Sh. Fujikawa on August 12.74, one of the young Japanese observational enthusiasts (12-cm reflector, x 20). /73
Prior to this, he independently discovered Comet 1968a, which received the names of the first three discoverers from whom communications arrived at the International Bureau of Astronomical Telegrams (Tago, Honda, Yamamoto), and Comet 1968c. This new comet was estimated to have m = 11^m, and it appeared as a diffuse nebulosity 3' in diameter, without a central condensation. The next day, on August 13.47, K. Tomita noted m = 11^m and a tail longer than 1°.

The comet moved to the east and, gradually dropping southward, passed through Gemini and Cancer, and in October it crossed the constellation Leo and Virgo. According to the estimates of Seki (Kochi), Mile (Nice), and Antal (Skalnate Pleso), the comet was 12^m on August 13.8, 14.1, 14.7, and 16.1. But, on August 18.1, 19.5, and 20.1, Mile and Van Biesbroeck gave m = 10^m. On August 16.5, it was $11^m.5$ (Seki). At the end of August, the comet was diffuse (Mile); on August 22.0, according to the estimate of

Burnasheva, m = 12 — 13^m (nucleus ?). From the start of September, the comet increased noticeably in brightness. On September 2.8, Seki gave m = 9^m and, later on September 4.81, $8^m.7$, September 10.83, $8^m.4$ — $9^m.0$, September 17.8, $8^m.7$, September 18.8, $8^m.8$, and September 19.8, $8^m.8$. According to Mile, on September 22.16, C > 20'.4. On October 18, Lockher (Switzerland, 8-cm astrograph) found m = 9^m. Based on plates taken by K. I. Churyomov and S. I. Gerasimenko with the 50-cm telescope of the Alma-Ata Observatory, m_{phot} = $7^m.0$ — $7^m.5$ on September 10.0; on September 18.0 — $6^m.5$ — $7^m.0$; September 21.0 — $6^m.0$ — $6^m.5$, and the tail was 60' in length and of Type I, while D = 1'.2. Based on visual observations by members of the ALPO, on September 8.52, — $8^m.7$ (Middlebrook), 13.4 — $9^m.0$ (Wooten); 21.0 — $7^m.9$ (Bortle), and D = 3', C = 20'. In October, the comet became difficult for observers in the northern hemisphere. On October 2, m = 7^m (Seki), on October 4 C > 20' (Mile), and on October 12, E. Roemer, using the Catalina reflector, found h = $13^m.5$, and a narrow tail 5' in length was visible visually. Based on Ts. Seki's observations at the end of October, in morning twilight m = 9^m. On February 8, 1970, Roemer did not find the comet at the ephermeris position and assumed that it must be fainter than 18^m.

Literature. IC, Nos. 2161 — 2174, and 2190; KTs, Nos. 87 — 94.

The initial orbits were calculated by M. Ya. Shmakova and G. Kastel' (KTs, No. 88), and by M. Ya. Shmakova and B. Marsden (IC, No. 2163). The orbit was by B. Marsden, based on 20 observations from August 13 through September 6 (IC, No. 2169); T = October 12.438, 1969, q = 0.774, and i = 8°93'. I. Hasegawa noted a similarity to the orbit of Comet 1702. The possibility was predicted of an appearance of a stream of radio meteors on about April 1.

The preliminary values of the absolute magnitude were H_{10} = $8^m.0$ (Shmakova and Kastel'), $9^m.0$ (Shmakova), and $8^m.5$ (Marsden) (KTs, No. 88).

On the basis of the cited estimates (24), the absolute magnitude for the period prior to perihelion was $H_{10} = 8^m.3 \pm 0^m.2$. A period of fall in brightness (August 14 — 17) and a sharp increase in the absolute brightness by almost $1^m.5$ on August 18 were noted; $h_{10} \sim 10^m.3$, and D_1 = 5' (August 13) and approximately 2' (September 21). The maximum length of the tail was S = 0.032 a.u. (K = 48° for September 21, 1969).

r and Δ: August 12, 1969 — 1.37, 1.68; August 17 — 1.30, 1.62; August 27 — 1.16, 1.49; September 6 — 1.04, 1.40; September 16 — 0.93, 1.37; September 26 — 0.84, 1.37; October 6 — 0.78, 1.42; October 16 — 0.78, 1.51; December 25 — 1.53, 2.26; February 3, 1970 — 2.08, 2.48; and March 15 — 2.60, 2.46. /74

1969 VIII — 1968g

This was the sixth observed apparition (1927 III — 1961 III) of the periodic Comet Comas-Sola. It was rediscovered by E. Roemer on a plate taken with a 60-minute exposure with the 61-cm reflector of the Catalina station on October 27.2, 1968, after two months of unsuccessful searching for it by Van Biesbroeck and also by search observations with the 60-inch reflector of the Okayama station of the Tokyo Observatory and at the European Southern Observatory (La Serena, Chile, 152-cm reflector). Based on Roemer's estimate, $m = 20^m$, and the comet was diffuse with a central condensation. The comet was found in Aquarius ($\alpha = 23^h06^m$, $\delta = -22°48'$) and was low for northern observers. It moved southeastward, and prior to conjunction with the Sun, it was photographed only on November 23 and 24 when very faint and

poorly centered images were obtained. According to calculations of K. Aksnes and B. Marsden, passage through perihelion should have occurred already on October 29, 1969.

On September 9.9, 11.9, and 21.9, 1969, the comet was photographed by K. I. Churyumov and S. I. Gerasimenko (Astronomy Faculty of Kiev University) with the 50-cm Maksutov telescope of the Alma-Ata Observatory (Kazakhskaya SSR). The comet was found in Gemini, had 15 — 16^m, and possessed a central condensation with a small tail. On September 13.13, 1969, B. Mile (Nice) estimated m = 17^m and characterized the comet as diffuse without a central condensation.

On September 12.87 and 15.88, 1969, the comet was observed at the Perth Observatory (Australia). J. Bortle and K. Scovill noted a small diffuse coma (D = 0'.3) elongated in the direction of a fan-shaped tail (2'.5, p = 277°) with a central ray on a photograph taken September 14. On September 21, the comet was barely visible with a 22-inch telescope, m = $13^m.6$, and a coma with D = 0'.5 and C = 3'. On October 4.10 and 9.07, Mile (Nice) found m = $15^m.5$ (evidently the central condensation with d = 10') and a tail 2' in length. In January, February, and March, positions were observed by the Kiev Expedition at Alma-Ata (Gerasimenko, Afanas'eva), Seki, Mrkos, and Mile, and also at the Perth Observatory. On February 2.59, T. Urata (Nikhondaichi Observatory, Shimizu, Shizuoka) found m = 13^m, D = 0'.4, and C = 5', with a small astrograph. At this time, the comet was at maximum brightness.

According to Roemer, on October 11, 1969, h = $16^m.8$ and a narrow tail was directed northwestward as far as 0'.1; on January 5, 1970 h = $15^m.8$ with traces of a tail to the northwest as far as 0'.3. On February 7, with the Catalina station reflector and

on February 13, with the Steward telescope h = $16^m.0$; a structureless tail to the west as far as 2' from the nucleus was visible on a 30-minute exposure. The nucleus and traces of a tail were visible visually. On March 14, using the 229-cm reflector, a strong central condensation of $17^m.0$ was obtained with traces of /75
a tail to the southwest. On April 7, it was photographed through clouds. On a plate taken June 1, 1970 (229-cm telescope), a stellar image of $m_2 = 19^m.3$ was obtained.

Literature. IC, Nos. 2083, 2173, 2188, 2195, 2212, 2227, 2235, 2264, and 2322; KTs, Nos. 84, 91, 99, 101, 103, and 116; Quart. Journ. RAS, Vol. 10, No. 3 1969; PASP, Nos. 481, 483, 484, 485, 487, and 489; Sky and Telescope, Vol. 38, No. 6.

The preliminary orbit was by K. Aksnes and B. Marsden, and T = October 29.14, 1969 UT, q = 1.7688, and P = 8.549 years.

The preliminary photometric parameters y = 15, $H_y = 8^m.5$, $H_{10} = 12^m.0$ (Marsden) served for the photometric ephermeris of the central condensation. The cited estimates, based on nine estimates of maximum brightness, gave for the comet integral brightness in the Galechek system $H_{10} = 10^m.7$ with a scatter of from $9^m.5$ to 12^m, $D_1 = 1'$, and S = 0.003 a.u. The absolute magnitude of the central condensation was $h_{10} = 12^m.8 \pm 0^m.1$ (it corresponds to m_2 in the notation adopted by IAU Commission 20).

r and Δ: October 11, 1968 — 3.61, 2.79; October 31 — 3.50, 2.90; December 10 — 3.27, 3.24; August 7, 1969 — 1.94, 2.45; August 27 — 1.87, 2.24; September 16 — 1.82, 2.04; October 26 — 1.77, 1.68; December 5 — 1.80, 1.39; January 14, 1970 — 1.92, 1.18; February 23 — 2.09, 1.16; April 4 — 2.30, 1.46; May 14 — 2.53, 2.04; June 23 — 2.77, 2.75; and August 2 — 3.00, 3.46.

1969 IX — 1969g

This new comet was discovered independently by three observers in Japan — A. Tago, Ya. Sato, and K. Kosaka. A. Tago first observed the comet on October 10.43 and repeatedly on October 12. The comet was discovered independently by Sato and Kosaka on October 12. At the moment of its discovery on October 10.43, the comet was diffuse without a central condensation, 10^m in brightness, and was found at the endge of Ophiuchus at the following position: $\alpha = 16^h20^m.0$, $\delta = -2°15'$. On October 12, according to the observations of Tago, Sato, and Kosaka, the comet was diffuse without a central condensation and $m = 9 — 10^m$.

In October and November, the comet moved in the southeastward direction and passed through Ophiuchus, and in December, it crossed through Scorpius and Corona Australis into Telescopium. At the beginning of January, moving east through Indus, it crossed into Grus and began to move southeastward, having become accessible to northern observers (Figure 16). In January, it passed through Sculptor, Cetus, and Pisces and, continuing its northeastward motion, in February it moved through Aries and Triangulum into Perseus. Then, fading rapidly, it moved in the eastern direction. After its discovery, the comet was observed in Japan, Australia, Argentina, France, and Czechoslovakia. On October 13.4, Kozai observed the comet as a diffuse object with a central condensation; Seki estimated the comet brightness to be $m = 10^m$; on this same day, Harwood (Western Australia) estimated the brightness to be 9^m. On October 14.47, according to Waterfield's observations (Woolston Observatory), the comet was $9^m.5$; on October 15.5, according to Woodrop's determination, the /77
brightness was equal to 9^m; on October 16.71, according to Antal, 10^m. On October 18.7 and 19.7, Antal found the comet to be diffuse, and its brightness fell to 11^m, and then, according

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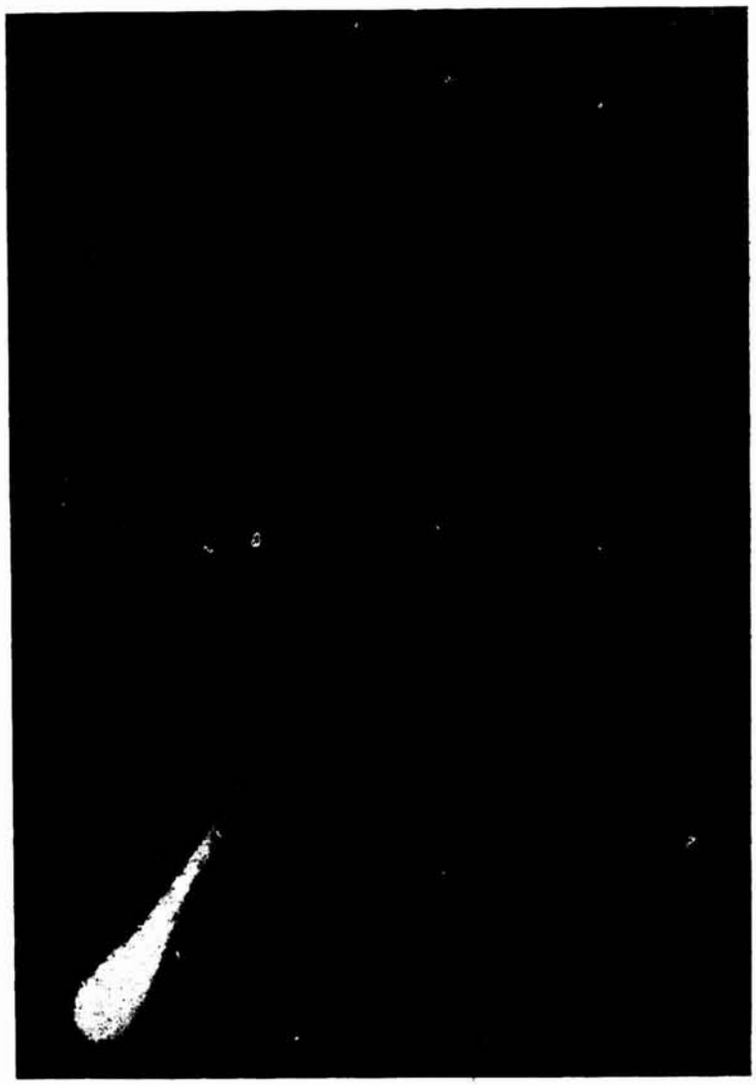

Figure 16. Comet Tago-Sato-Kosaka, 1969 IX. Photographed by H. I. Potter, Chile, Pulkovo Metric Duo-meniscus astrograph, January 4, 1970.

to Seki's observations, it increased to 9^m on October 22.4 and to $8^m.5$ on October 31.39. Observations of the comet in November were difficult, and only on November 27.0 did F. Dossen (European Southern Observatory) observe the comet at 7^m and obtained an emission spectrum without a continuum. From

December 7 through 11, Gerber and S. Gonzales observed the comet in Argentina; on December 8.0, the comet brightness was equal to 6^m, the coma diameter was 2', the nucleus diameter was 0'.5, and a tail was not visible in the twilight. Prior to perihelion passage, A. Jones and MacMillan observed the comet in New Zealand and estimated m = $4^m.4$ — $4^m.1$ on December 20.4. Z. Pereyra (Cordoba, Argentina) observed a tail 0°.5 — 1° in length on December 20 at position angle p = 156°. On December 21.26, the comet passed through perihelion and at the end of December, it was widely observed at southern observatories. On December 24.015, according to Pereyra's observations, m = $3^m.0$. On the succeeding days, the comet brightness increased and was, according to Pereyra's estimates, equal to $2^m.9$ on December 25.014, m = $2^m.8$ on December 26.011, m = $2^m.7$ on December 29.01, m = $2^m.6$ on December 30.014, and m = $2^m.6$ on December 31.022; on December 31.4, Pereyra noted a tail about 7° in length. At the end of December, spectrograms of the comet were obtained by E. Pereyra and F. Dossen. On December 25.4 and 31.4, Matchett and A. Jones observed the comet in Australia; on December 28, B. Mintz at Cerro-Tololo estimated the comet brightness to be m = $2^m.3$ and noted a tail 5° in length. According to Jones' observations, the comet brightness increased at the end of December from $4^m.4$ on December 26.4 to $3^m.8$ on December 30.42. The tail length during this period was 3° — 3°.5 at p = 150 — 160°. /78

On January 1.016 and 2.013, 1970, Pereyra estimated the comet brightness to be $2^m.6$ and noticed, on January 2, a tail 10° in length which indicated that a Type II tail was divided into two parabolic branches surrounding a luminous Type I tail. On January 2 and 3, the comet was observed by Soviet sailors on the ship "Ussuriysk." Panov communicated from the whaling vessel "Sovetskaya Rossiya" about an observation on January 2 of the comet tail being 2°.5 in length. Jones determined, on January 2.42,

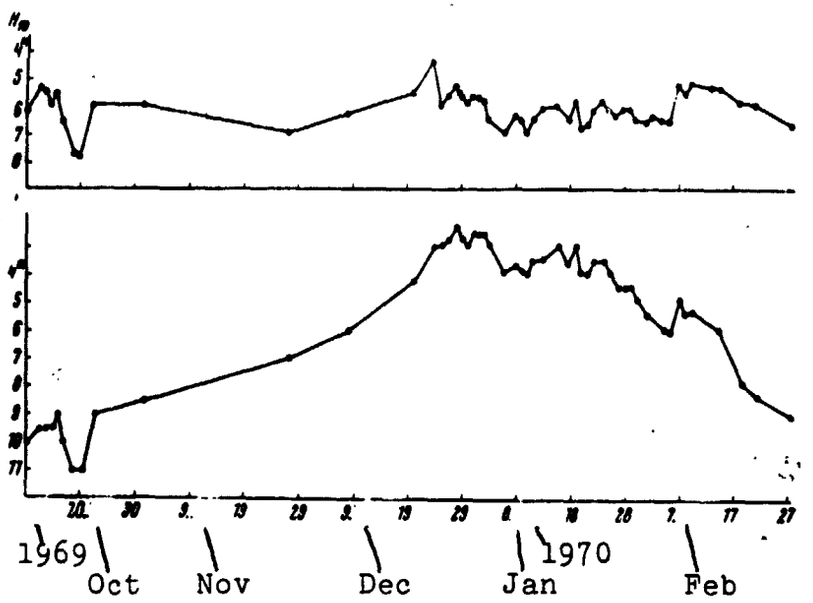

Figure 17. Curve of the variation in the absolute brightness of Comet Tago-Sato-Kosaka 1969 IX (above) and a composite curve of brightness estimates which are not reduced to unit distance from the Earth and from the Sun (below).

the comet brightness to be $3^m.6$ and its nucleus $6^m.9$, and he estimated the tail length to be 5° at p = 146 — 156°; on January 3.46, according to Jones, m = $3^m.7$ and C = 4°; on January 5.41 and 6.44, m = $4^m.5$, D = 4', and C = 7° at p = 140° and 150°, respectively. On January 8.42, according to Matchett's observations, m = $3^m.7$ and C = 6° at p = 134°, and on January 9.42, according to Jones, m = $3^m.9$ and C = 7° at p 140°. On January 10, MacMillan, Jones, and Matchett estimated m = $4^m.3$, C = 6 — 7° at p = 115 — 130°, and D = 6'. On January 11.42, m = $4^m.3$, C = 6° at p = 130°, and D = 7' (Jones). On this same day, on January 11.96, Jose DeSilva (Curitiba, Brazil, Parana College Observatory) estimated the comet brightness to be m = $2^m.9$. On January 12.42 and January 13.42, Jones and MacMillan estimated m = $4^m.2$; according to the observations of Jose DeSilva, m = $2^m.9$. On January 14.597, A. Code, T. Houck, and K. Lilly observed the comet in the ultraviolet using the OAO Space Observatory. On January 15, MacMillan and Mattei estimated the comet brightness to be m = $4^m.4$,

and Scovill communicated m = $4^m.8$. Jose DeSilva estimated the comet brightness to be $3^m.0$ on January 16.99. According to Sugako's observations, m = $4^m.2$ on January 17.40, and Mile estimated m = 3^m on January 17.7. On January 18, McCants determined m = $3^m.6$, and on January 19, Olivares, Seki, and Mile identically estimated m = $3^m.0$; Sugako gave, for this date, a lower estimate of m = $4^m.4$. The tail length was C = 3°.5 (Olivares). On January 20, members of the ALPO cometary section observed the comet, and their estimates varied from $3^m.0$ (Smith) to $4^m.5$ (Sugako, Wooten). R. Minton photoelectrically determined m = $4^m.24$ for this date. On January 21, brightness estimates by Seki, Lambert, Sugako, Smith, and Milon were in the range $3^m.6$ — $4^m.4$ and amounted to $4^m.0$ on the average. On January 22.0 and 23.0, J. Bortle estimated m = $4^m.0$ and D = 8', and Smith and DeSilva gave m = $3^m.6$ and D = 10'. S. K. Vsekhsvyatskiy at Kiev determined m = $4^m.2$ and D = 4' on January 23.69 and m = $4^m.4$ — $4^m.3$ on January 24.26. Smith and DeSilva communicated m = $3^m.6$ and D = 14' (Smith) for January 24.96. On January 25.1, according to Miller's estimates, m = $4^m.5$ and D = 10', and DeSilva gave m = $3^m.9$ for January 25.96. On January 26.68, V. M. Chernov observed the comet at Zaporozh'e and estimated m = $5^m.5$ and D = 15'. On January 27, the comet was observed at Saratov at the Artificial Earth Satellite Station and in Japan; in Bulgaria, Kazakov, Ganchev, and Gogoshev estimated the brightness to be about $4^m.5$, D = 30', and C = 3°.3. On January 28.46 and 29.44, Sugako estimated the brightness to be $4^m.9$ — $5^m.0$ (p = 76°), and S. V. Drozdov (Novgorod, 30 x 8 binoculars) determined m = $4^m.46$. On January 30.75, according to an estimate by S. K. Vsekhsvyatskiy, m = $5^m.0$ and on January 31, Vsekhsvyatskiy and Bortle agreed in estimating m = $5^m.2$. On January 29.74, G. S. Romashin (Kaurovskaya Astronomical Observatory of Ural University) estimated the diameter of the central condensation to be 0'.4. N. S. Chernykh (Krimean Astrophysical Observatory) photographed the comet on January 30.75 with the

/79

40/170 double camera astrograph and noted D = 15' and a melon-shaped head; a tail as long as 10° at p = 110° and out to 3° at p = 78° was also noted. On January 31.74, according to Chernykh's observations, the structure of the Type I tail was varying greatly: the tail appeared to consist of diverging rays, and it was noticeable at a large distance. The diameter of the central condensation was approximately 1' with a sharp condensation. According to S. Furia's observations (Valeze Observatory) on January 31.7, a Type I tail was formed of two straight-line branches 1°.6 and 2°.3 in length at an angle of 37°.3.

In February, the comet was widely observed at Kiev (Vsekhsvyatskiy), Tartu (Raudsaar), Krimea (Chernykh), Abastumani (Dzhapiashvili, Beytrishvili, Khatisov), at the Shemakhinskiya Observatory (Babaev, Gadzhiev, Gusev), by the Kiev University Expedition at Abastumani (Churyumov, Il'chishina), and Alma-Ata (Gerasimenko, Afanas'ev), at Saratov at the Artificial Earth Satellite station, and at other places. A large series of observations was carried out by members of the cometary section of ALPO (Bortle, Jones, Matchett, and others). On February 1 and 2, the comet brightness was about $5^m.5$ — $5^m.6$ (Vsekhsvyatskiy, Sugako, Bortle). According to Bortle's observations, the comet brightness on February 3.48 decreased to $6^m.2$; on February 4 and 5, it was equal to $6^m.0$ — $6^m.1$, and towards February 6.46, it increased to $5^m.6$ (Figure 17). E. Roemer estimated the comet integral brightness to be m = $5^m.0$ on February 3, using a pair of 7 x 35 binoculars, and on February 7.1, m = $5^m.3$, and she noted a bulge 1' in size at an angle of 135° to the Type I tail. According to J. Bortle's estimates, m = $5^m.5$ on February 8.0, m = $5^m.4$ on February 9, and then the brightness decreased: on February 11.49, m = $5^m.7$, 13.0 — m = $5^m.9$, 14.0 — m = $6^m.0$, 18.0 — m = $7^m.0$, and 21.0 — m = $7^m.5$. The comet brightness increase at the beginning of February was also noted from observations at

Abastumani; at the Shemakhinskaya Observatory, M. B. Babaev, M. S. Gadzhiev, and E. B. Gusev carried out, at the beginning of February, extensive spectral, photometric, and polarometric observations of the comet and noted a sharp increase in the comet brightness from February 5 to 7 along with noticeable variations in spectrum. The development of an envelope was noted on February 7 and 8 which reached diemsnsions of approximate 5' (Figure 18). On February 13.0, E. Roemer estimated the comet brightness to be $6^m.5$. In March, the comet was observed in the Krimea (Chernykh), at the Klet' Observatory (Mrkos), at the Catalina station (Roemer), and other places. On March 3.8, according to Chernykh's observations, the comet was circular and diffuse and had m = 9 — 10^m, D = 1' with a central condensation. Mrkos observed the comet on March 7, 9, and 10, and also March 30 and 31, and the first ten days of April.

On April 6, a sharply condensed nucleus of $17^m.2$ with traces of a coma was detected on a photograph taken with a 30-minute exposure by E. Roemer with the 154-cm reflector; it was clearly visible visually. On May 4, E. Roemer photographed the comet with the 154-cm reflector, and a condensed image of $18^m.1$ was obtained (30-minute exposure).

Literature. IC, Nos. 1275 — 2235; KTs, Nos. 89 — 106; PASP, Nos. 484 — 488; and Sky and Telescope, Vol. 39, Nos. 2 — 4, 1970.

On the basis of 68 estimates of the integral brightness reduced and averaged for each date, the absolute magnitude was $H_{10} = 6^m.25 \pm 0^m.30$. The comet was somewhat brighter after perihelion: $H_{10} = 6^m.30$ (from estimates prior to perihelion) and $H_{10} = 6^m.24$ (from estimates after perihelion). The photometric parameters were y = 11, $H_y = 6^m.6$, $D_1 = 13'.3$ (January 27, 1970), /81

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Figure 18. Comet Tago-Sato-Kosaka after the outburst of February 6 — 7. Photographed by N. S. Chernykh (Krimean Astrophysical Observatory, 40-cm astrograph), February 8.736, 1970, 60-minute exposure.

and S_1 = 0.119 a.u. (January 2, 1970). The curves of the comet brightness variation during the entire period of observation and variation of the absolute magnitude (H_{10}) are given in Figure 17.

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Figure 19. Spectrum of Comet Tago-Sato-Kosaka, 1969 IX. Taken by K. I. Churyumov with the 70-cm meniscus telescope of the Abastumani Observatory (8° prism), February 24.80, 1970, 40-minute exposure.

The comet spectrum (Figure 19) was first obtained on November 27, 1969, by F. Dossen (European Southern Observatory), who noted the presence of an emission spectrum without a continuum. On December 27, Z. Pereyra obtained spectrograms of the comet (with an objective prism); the spectrogram showed a faint continuum with bands, the C_2 (1.0) band being brighter than the CN (0.0) band. In the tail spectrum, a continuum and CO^+ emission was detected.

The spectrograms from December 28, obtained by F. Dossen, reveal strong C_2 and CN bands, faint CH and C_3 bands, and also a faint and narrow continuum. In the tail spectrum, the CH^+ and CO^+ bands are isolated with nicely resolved rotational structure.

Z. Pereyra noticed, on a spectrogram taken December 30, a brighter continuum than on December 27; the tail spectrum is more apparent in the red spectral region. Spectrograms obtained by H. Abt at the Kitt Peak Observatory showed strong CN and C_2 emission and also emissions of CH, C_3, and others. Abt pointed

out that the (0 — 0) rotational structure of the CN band was partially resolved.

Exceedingly interesting results were obtained on January 14.597 by A. Code, T. Houck, and K. Lilly from an observation of the comet ultraviolet radiation with the help of the Orbital Astronomical Observatory OAO-2 of the University of Wisconsin. With the help of a UV-photometer and spectrophotometer, the comet /82 head was observed in the bright L_α line as far out as distances 30' from the nucleus and was measurable as far out as 1°.5. The presence was noted of strong emissions near 3070 Å (possibly OH), and also a continuous spectrum was detected with a brightness minimum near 1900 Å and a strengthening of the intensity toward 1100 Å. This was the first comet for which observations were made in the ultraviolet.

The measurements of the comet infrared emission made in January and the beginning of February by coworkers from the Lunar and Planetary Laboratory showed that the infrared radiation intensity was greater at 10 and 20 microns than at 5 microns.

D. Coffeen used the 154-cm reflector of the Catalina station to photoelectrically measure the linear polarization near 6500 and 3600 Å. On January 20 and 22, the degree of polarization was equal to 19 and 13%, respectively.

r and Δ: October 10, 1969 — 1.62, 2.08; October 20 — 1.47, 2.04; November 27 — 0.78, 1.65; December 8 — 0.62, 1.48; December 20 — 0.51, 1.17; December 30 — 0.54, 0.83; January 5, 1970 — 0.60, 0.63; January 15 — 0.77, 0.41; January 25 — 0.94, 0.40; February 5 — 1.12, 0.62; February 21 — 1.40, 1.05; March 5 — 1.59, 1.39; March 25 — 1.91, 1.94; April 10 — 2.15, 2.37; and May 10 — 2.43, 2.86.

1970 I — 1970a

Daido-Fujikawa. According to a communication from Professor Hirose, Director of Tokyo Observatory, this comet was discovered on January 27, 1970, in Japan by enthusiasts and comet seekers; the comet was found in Aquila in the morning sky and appeared as an object of 8^m without a central condensation or a tail. It obtained the name Daido (Sendai Observatory, January 27.833) and Fujikawa (Onokhara, January 27.869). Later, it was explained that the comet was discovered already on January 26.85 by the amateur Kozai and estimated to be 7^m; he observed it on January 27.847.

The comet was moving towards the Sun and rapidly increased in brightness, continually entering the dawn cone. The first accurate positions were determined by M. Honda (January 27.870, $m = 8^m$); T. Urata, Ts. Seki also estimated the brightness to be 8^m on January 28.845 — 28.860, and a tail with C = 20' at p = 330° was noted.

On January 31.86, according to Seki, $m = 7^m.7$; on February 2.85, K. Tomita (Tokyo Observatory) found $m = 6^m$, and T. Urata almost simultaneously observed $m = 7^m.0$, C = 0°.5. Later on, B. Mile at Nice estimated the brightness to be 7^m on February 4.21, while Kozai (Tokyo Observatory) noted $m = 5^m$ on February 4.85. According to Seki, $m = 5^m.5$ on February 5.88; on February 6.85 — 6.86, T. Urata gave $m = 6^m$, C = 1°.5 and K. Tomita found 5^m, while Ts. Seki estimated $5^m.1$. According to Tomita, $m = 4^m$ on February 7.85, and the comet was diffuse with a condensation and a tail >1° in length. Already, eight hours earlier, E. Roemer saw, in a pair of binoculars, a tail in the bright twilight sky with a length of at least 4°. According to Ts. Seki, $m = 4^m$ on February 9.88; however, the comet was at this time 18° in all from the Sun, and estimates in the bright sky near the horizon could not be certain.

It was not observed after February 9. In the middle of February, it should have passed through perihelion, being located 4° in all from the center of the solar disc. At this time, the /83
comet might have reached -3^m apparent magnitude; however, searches for the comet in the daytime near the Sun gave no results. In March and April, it should have rapidly faded, slowly moving away from the Sun. It was not observed anymore.

Literature. IC, Nos. 2203 — 2216; KTs, Nos. 97 — 98; PASP, No. 485.

The comet orbit calculated by B. Marsden was similar to Comet 1577; it belonged to the class of orbits with small perihelion distances. T = February 15.8, 1970, q = 0.0657 a.u., and i = 100°.13. The preliminary value of the absolute magnitude was H_{10} (Marsden) = $8^m.5$; Marsden's photometric parameters were y = 15, $H_{15} = 10^m.5$ (IC, No. 2210).

The average of the collection of 20 cited estimates from January 26 through February 10 was $H_{10} = 8^m.6 \pm 0^m.14$. Upon discovery, the comet was somewhat brighter; then estimates of its absolute brightness decreased somewhat, which was evidently associated with the difficulty in observing the comet in the twilight sky. The value y = 10 (n = 4) was in completely satisfactory agreement with the observations. The maximum tail length noticed (February 7.5, K = 77°) was larger than S = 0.077 a.u.

r and Δ: January 27.0, 1970 — 0.78, 1.45; February 1.0 — 0.63, 1.15; February 5.0 — 0.49, 1.06; February 10.0 — 0.30, 0.98; February 15 — 0.084, 0.95; February 20 — 0.24, 1.13; March 5 — 0.67, 1.47; and March 25 — 0.93, 1.69.

1970 II — 1969i

J. Bennet of Pretoria (South Africa) discovered this comet on December 28.8, 1969, as a result of systematic searches. This was his 153rd hour of observations in 1969 (in all, 333 hours since 1967), observations which he made with a 5-inch telescope having a magnification of 21 x. The comet was in the constellation Tucana ($\alpha = 1^h0^m$, $\delta = 65°.8$) and had a brightness of $8^m.5$. Already on the next nights, the new comet was observed at satellite stations of the Smithsonian Astrophysical Observatory in Olifants Fonteyn (Africa) and Woomera (Australia) and estimated to be $8^m.5 — 9^m$. The comet slowly shifted to the southwest, and already, by January 6, M. Candy was able to find a preliminary parabolic orbit based mainly on the first accurate position obtained at Perth Observatory (West Australia). The ephermeris showed that the comet should become a very bright object in March — April, being favorably positioned for observers of the northern hemisphere. In January, the comet crossed the constellation Tucana, in February it moved through Grus, in March it rapidly crossed Piscis Austrinus and Aquarius, and on March 26, it crossed into the northern sky, having become one of the brightest comets of our century ($1^m — 0^m$). The comet was widely observed by astronomers — specialists and amateurs — first of the southern, and then of the northern hemispheres. Harris (Perth) estimated $m = 8^m$ on December 30.6, and Pereyra (Cordoba Observatory, Argentina) found, on January 13.10, $m = 7^m.7$; January 15.05 — $7^m.5$, and a Type I tail 22' in length; and on January 21.04, $6^m.8$. On January 3, the comet was observed at the Cerro-Kalan and Cerro-El Roble stations of the University of Chile Observatory by Chilean and Soviet astronomers. Based on observations at Perth Observatory, the tail was 1° or longer already on January 29. Pereyra and Rodrigez (Bosque-Alegre) photographed a tail 2° in length through a blue filter at the

/84

beginning of February. Estimates of the comet integral brightness which were published in the IC, KTs, and the ALPO Bulletin (Milon, et al.), are collected together in Table 3, where the average reduced value of H_{10} for the corresponding days and the values of lg r and lg Δ are given.

The observers are denoted as follows: Antal (An), Bennet (Be), Bettin (Bt), Belitskiy (Be), Bortle (Bo), Vsecksvyatskiy (Vs), Woomera (W), Harris (Ha), Gerber (Ge), Demenko (De), Dzhapiashvili (Dp), Drozdov (Dr), Jones (J), Krivoshey (Kr), Li (Li), Milon (Ml), Matchett (Ma), MacMillan (MM), Marsden (Mr), Nadubovich (Na), Olifantsfontein (O), Pereyra (Pe), Roemer (Roe), Rodrigez (Ro), Seki (Se), Simmons (Si), Smelyanskiy (Sm), Fedynskiy (Fe), Chernov (Che), Chistyakov (Chi), and Churyumov (Chu).

The values of $m_2(h)$ were: January 2.5, 1970 — $12^m.9$; March 25.5 — 6^m; June 1 — $15^m.0$; June 30.8 — $15^m.5$; July 27 — $15^m.8$.

The values of h_{10} were: June 1 — $11^m.7$; June 30.8 — $10^m.7$, July 27 — $10^m.0$; and August 25.2, D = 4'.

Here an apparent decrease in brightness is noticeable from a comparison of estimates for nearby dates, which is associated with the comet low altitude above the observers' horizon (for example, the average of the estimates of Simmons and Lea for March 25.5) and with the low altitude of the observation site above sea level or city illumination (comparison of the estimates obtained at Kiev or Zaporozh'e with the estimates of Antal). Nevertheless, discrepancies exceeded 1^m in rare cases, and they were usually within the limits of several tenths of a stellar magnitude. The majority of the observers, both the European and the American (ALPO), used for comparison stars the system of the

TABLE 3

BRIGHTNESS ESTIMATES OF COMET BENNET

Average time of Observations		m_1	Observers	lg r	lg Δ	H_{10}
1969						
December	28.8	$8^m.5$	Be	0.229	0.237	$5^m.0$
	29.8	8.5	O	.224	.235	5.0
	30.5	9	W	.222	.234	5.6
	30.6	8	H	.221	.234	4.6
	31.5	9	Ma	.218	.232	5.7
1970						
January	2.5	8.5	J	.209	.229	5.3
	5.5	9	Ma	.196	.224	5.9
	10.4	8.7	MM	.173	.215	5.9
	11.5	8.5	Ma	.170	.213	5.7
	13.1	7.7	Ro	.161	.211	5.0
	14.1	7.6	Ro	.156	.209	5.0
	15.0	7.5	Ro	.151	.207	5.0
	18.4	8.8	MM	.138	.201	6.4
	20.0	7.0	Pe	.127	.198	4.7
	21.0	6.8	Pe	0.121	.196	4.6
February	15.4	5.3	MM	-0.043	.123	5.1
	21.4	4.9	Ma	.091	0.093	5.4
March	10.8	2.3	J	.228	-0.049	4.8
	13.4 — 13.8	1.0;1.7	Ge, Ma	.248	0.75	3.8 - 4.5
	18.4	0.5	Ro	.265	.113	3.7
	21.4	0.5	Pe	.267	.135	3.7
	22.8	-0.5	Se	.266	.145	2.9
	25.4	1.5	Mr	.258	.157	<4.9
	25.5 — 25.6	-1.0;1.6	Li, Si	.258	.157	2.4 - 5.0
	26.6 — 26.8	0.0;0.42	Li, Chi	.252	.155	3.3
	27.0 — 28.4	1.5;1;0.5	Fe, Sm, Bo	.238	.149	$4^m.6 - 4^m.1$
	29.1	0.7	Chu, De	.235	.148	3.8
	30.8 — 31.1	1.23;1;1.15	Chi,Vs,Che	.230	.138	4.0 - 4.5
	31.8	1.1	Chi	.221	.135	3.6 - 4.0
April	1.0 — 1.4	1.2;1.5;0.8	Vs,Che,Bo	.218	.135	3.6 - 4.3
	1.8 — 2.1	1.0;0.0	Chi, An	.212	.131	3.8 - 2.8
	2.7	1.0	Dp	.208	.127	3.8
	3.8	1.2	Chi	.198	.125	3.8
	4.4 — 5.0	1.2;1.3;1.5	Bo,Chi,Vs	.190	.114	3.8 - 4.0
	5.0 — 5.4	0.9;1.4	An, Bo	.187	.112	3.3 - 3.5
	6.4 — 6.7	2;1.4	Bo, Be, Na	.175	.098	3.7 - 4.3
	6.9 — 7.1	1.9;1.0;1.6	Na,An,Che	.167	.090	4.0 - 3.1
	7.8 — 8.1	2.3;1.4;1.5	Chi,Vs,Che	.165	.080	3.4 - 3.9
	8.4	1.9	Bo	.155	.076	3.8
	9.0	1.3	An	.150	.075	3.2

Continued

TABLE 3

(Continued)

Average time of Observations		m_1	Observers	lg r	lg Δ	H_{10}
April	9.8	2.3	Chi	.148	.070	$4^m.1$
	10.0 — 11.0	2.1;1.4; 1.7;2.3	An,Che,An; Vs	.145	.065	3.2 - 4.2
	11.3 — 11.8	1.9;3.0	Bo, Chi	-0.135	-0.055	3.6 - 4.6
	12.1 — 12.8	2.0;2.2;2.8	An,Chi	-0.125	-0.048	3.7 - 4.3
	13.1 — 13.8	2.1;2.4;3.1	An,Bo,Chi	.115	.025	3.4 - 4.4
	14.8	2.9	Chi	.100	-0.020	4.0
	15.1 — 16.1	2.9;4.0;2.8	Kr,An,Dr	.088	0.000	3.8 - 3.7;4.9
	16.7 — 17.0	4.3;3.5; 2.7;3.3	Na, Vs Dr, Che	.077	.005	3.4 - 5.0
	18.1	3.0	An	.065	.020	3.6
	19.0	3.3	Vs	.060	.025	3.6
	21.1	3.4	An	.050	.035	3.8
	22.1	3.4	An	.040	.045	3.6
	23.0	4.2	Che	.032	.057	4.2
	24.6 — 24.8	4;4.5;4.3	Na, Vs, Vs	.020	.075	3.8;4.3; 4.1
	25.8	4.2	Vs	-0.010	.87	4.0
	26.9 — 27.1	4.8;4.2	Dr, An	0.000	.100	4.3 - 3.7
	29.6 — 30.1	5.5;4.9	Na, An	.020	.127	4.7 - 4.1
May	3.9 — 4.6	5.3;5.6	Dr, Na	.045	.155	4.1 - 4.7
	5.8 — 5.9	4.9;4.7	Vs, Dr	.055	.165	3.6 - 4.3
	6.9	4.8;5.9	Vs, Dr	.060	.170	3.3 - 4.4
	7.8	5.3	Vs	.067	.177	3.7
	8.8	5.4;5.9	Vs, Dr	.074	.182	3.8;4.1
	9.8 — 10.1	5.4;5.0	Vs, An	.080	.190	3.7;3.2
	10.9 — 11.1	6.0;5.4	Dr, An	.085	.200	4.2,3.6
	11.9 — 12.0	5.3;5.3; 6.2;5.5	Vs, An Dr, An	.093	.205	3.4 - 4.1
	15.8 — 16.0	6.2;6.5	Vs, An	.112	.227	3.9;4.2
	18.95	6.7	An	.130	.245	4.2
June	1		Roe	.183	.304	
	5.0	8.5	An	.205	.318	4.9
	5.9	8.5	An	.208	.322	4.8
	6.9 — 7.0	8.7;8.8	An, An	.214	.326	4.9;5.0
	8.0 — 8.3	8.9;7.2	Bo, Bt	.220	.330	5.1;3.4
	8.8 — 9.1	7.8;8.8; 8.5 - 9;7.5	An, Ml, Vs	.224	.333	4.0;5.0
	15.0 — 15.2	9.4;7.7	An, Bo	.247	.350	5.2;3.5
	18.9 — 19.0	10;9.7	An, An	.261	.359	5.6;5.3
	19.9 — 20.0	10.0;10.0	An, An	.264	.362	5.5;5.5
	20.9 — 22.0	10.0;8.0;10.2	An,Bo, An	.271	.368	3.5;5.6
	22.9	10.2	An	.289	.375	5.6
	29.2; 29.8	8.1; 8.9	Bo, Bt	.292	.381	3.3;4.1
	30.8 — 1	8.9	Bt, Roe	.298	.384	4.1

Continued

TABLE 3

(Continued)

Average time of Observations		m_1	Observers	lg r	lg Δ	H_{10}
July 1.9 —	2.0	11.0;11.0	An, An	.302	.386	6.0;6.0
	6.3	8.5	Bo	.313	.393	3.5
1970	8.2	8.3	Bo	.318	.396	3.2
	9.8	8.2	Bt	.324	.399	3.0
	13.3	8.3	Bo	.333	.406	2.9
	27		Roe	0.374	0.426	
Middle of August		9	Roe	0.420	0.444	2.6
	25.2	9.8	Bo	.443	.446	3.1
September	2.2	10.2	Bo	.456	.450	3.4
	13.4	10.6	Bo	0.474	0.452	3.6

SAO catalog, and this resulted in a close agreement of the estimates.

In February — March, the comet was observed at observatories of the southern hemisphere. It is necessary to note first of all the lengthy series of position determinations at the mountain station of the Cordoba Observatory (Pereyra, Rodrigez), at Perth Observatory (Western Australia: Candy, Harris, Harwood, and others), at the mountain observatories of the University of Chile (with the Pulkova Observatory metric telescope of Maksutov system; Potter, Lokalov), and at the Cerro-Tololo Observatory (Westerland, Mintz).

At the beginning of March, the comet became a noticeable object in the sky after its emergence on March 7 from the proximity of the Sun, and it attracted the attention of sailors located in the oceans of the southern hemisphere. At Moscow and Odessa, a large number of radio communications were obtained about the comet, which was independently discovered by crews of Soviet ships. On March 6 — 7, 1970, Captain Baumanas observed

the comet tail at an altitude of 8°; in the middle of March, the crews on the exploratory ships "Akademik Kinpovich, "Mendeleyev," and others observed a bright comet with a tail 4 — 5° in length. Still, on March 10, $m = 2^m.3$, $C = 4°$, $p \approx 210°$ (Jones); on March 13, $m = 1^m.7$, $C = 4°$ (Matchett). The bright comet tail was a classical conoid of Type II, although, on the photographs, /87
numerous radio structures and filaments along the entire tail were visible, which were reminiscent of the mane of a horse. From March 27 — 28, the comet was widely observed by astronomers of the northern hemisphere, having by this time turned into one of the brightest objects in the sky. As Table 1 indicates, the integral brightness of the head on March 30 — 31, exceeded 0^m (even -1^m); the comet crossed the equator with a speed of almost 3° per day and passed through Pegasus along the 22^h and 23^h hour circle; then it crossed Andromeda, and from the end of April, it moved through Cassiopeia into Camelopardalis, remaining a near polar object in August — September.

Pereyra (Cordoba Observatory) noted, on March 23.4, in a spectrum of the tail and head, emission bands and a bright continuous background, as well as a "dust" tail 10° in length. J. Bennet of Pretoria saw a tail as long as 11° with the naked eye on March 20.1. On March 22, the central condensation was $1^m.0$. Outflows were observed with an 8-inch reflector from the central condensation in the direction of the Sun; a straight gaseous tail of the same brightness as the "dust" tail inclined at an angle of 20° was noted on the photographs. From March 21, the comet was photographed with an AFU-75 camera at Asgoi (Somali, observers were Kolesnik, Balodis, and Ibragimov at the Soviet satellite station). Only a classical Type II tail turned out on the panchromatic film.

K. Simmons saw a nucleus with h = $6^m.0$ and d = 0'.2 — 0'.4 and a coma of 5' on March 25.5 in Florida. He saw, with the naked eye, a fan-shaped tail as long as 2°.5 (p = 225°) and an opposing tail at p = 90° with outflows at p = 75 and 105°. Li at Honolulu found m = 1 on March 25.6 and 1^m fainter on the next day. On March 28.4, Bortle saw a bright tail out to 5° as a curve under bright lunar illumination; outflows of fountain-type were observed from the nucleus similar to those observed by Seki and Schmidt with comet 1861 II. On March 28.07 and 30.08, the comet was observed at Kiev, having an integral brightness of $0^m.7$ with a broad curving Type II tail, C = 7°, a yellow-colored nucleus, h = $1^m.2$ (Figure 20).

On March 31 and April 1 — 4, an exceedingly interesting outburst of material of the Type I tail, having burst through the outer boundary of the curving tail (Figure 21), was recorded by observations at Abastumani (Dzhapiashvili, Shapovalova, and Beytrishvili); exceptional activity of the comet was observed during this period. At Kiev, from March 31, it was observed each morning by S. K. Vsekhsvyatskiy with the large 4.2-meter astrograph: on April 1.04, m = $1^m.2$, D = 3'.0; on April 5.06, $1^m.47$, C = 7° and at 250 x, a bright nucleus of 3^m with outflows and a sharp outer parabolic envelope; on April 8.06, $1^m.43$, C = 5°. /90 On April 11.05, $2^m.20$, C = 10°. A variation in the structure of the head was noticeable. On April 17.03, $2^m.66$, C = 7°; and on April 19.05, $3^m.30$, and a star-like nucleus of 10^m was noted. A tail was photographed with the 16/100 cm camera (Vsekhsvyatskiy, Churyumov).

The comet spectrum which F. Dossen observed at the European Southern Observatory (Chile) in the middle of March was characterized by a strong continuous background (which the observer ascribed to "dust") and CN, C_2, CH, C_3, NH, and Na emissions,

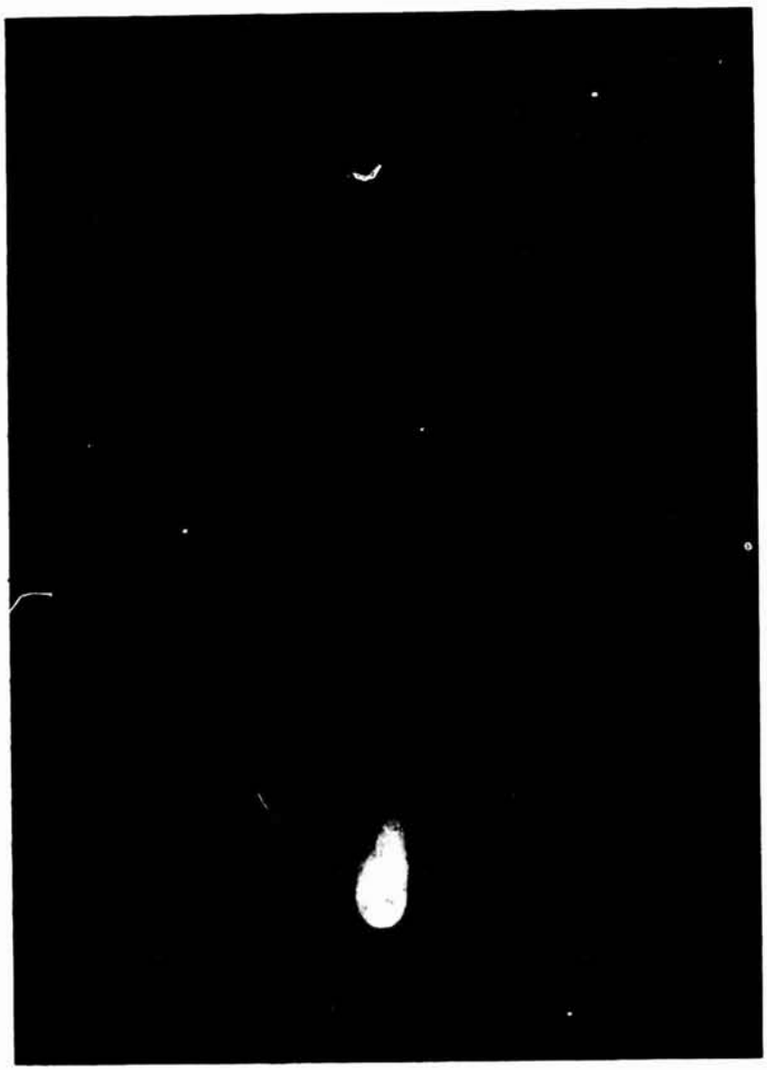

Figure 20. Comet Bennett, 1969i. Photographed at Gor'kiy with an AVR-3 telescope, April 2.02, 1970, 18-minute exposure. The observers were A. P. Poroshin and V. Kuznetsov.

as well as OH^+, CH^+, and CO^+; the presence of a new band (1 — 1) CN, which was discovered earlier in Comet Tago-Sato-Kosaka, was noted.

Figure 21. Comet Bennet, 1969i. Photographed by A. [illegible]povalovaya (Kiev State University) on April 4.042, 1970, with the Abastumani Observatory meniscus telescope.

Beginning from March 28 and until April 5, a large number of photographs were taken with the large Schmidt camera and the 122-cm reflector of the Asiago Observatory (observers were Bernacca and Mammano); a Type I tail varied greatly from day to day with irregular CO^+ outbursts. On April 3, a Type I tail > 4°2 in length was separated from the coma; a Type II was almost

4°5 in length. The spectrum contained the well-known cometary bands against a very strong continuum; in the infrared region, the (0 — 0) band of the IP system of CH λ 9148 Å was detected against a continuous background using an image-converter tube.

Observations of the positions during this period were made by Mile (Nice), N. S. Chernykh (Krimean Astrophysical Observatory), A. Mrkos (Klet'), M. Antal (Skalnate Pleso), Ts. Seki (Dodeira), Bruver (Khertbisport), A. Debeon' (Uccle), R. Waterfield (Woolston), and others. J. Bortle (Mount Vernon) estimated the comet brightness from March 28 with the naked eye and made observations with a 56-cm Maksutov camera visually and photographically; shifts of the outbursts to the east of the nucleus were noted, along with a general activity of processes in the head (envelopes similar to Comet 1858 VI); the "shadow" of the nucleus was usually very distinct. On April 5 and 6, a Type I tail was visible as far out as 12°; on April 12 and 13, the main tail was traced at least as far as 20°.

The comet was observed and photographed at the Ussuriyskaya Solar Station (Shistyakov), at Zaporozh'e (Chernov), Novgorode (Drozdov), at the Kaurovskaya Observatory of the UGU (Katnikov), at Dushanbe (Bakharev and others), and by numerous amateur astronomers.

V. P. Dzhapiashvili at Abastumani estimated C = 15° on April 2.7 and measured the polarization in the head to be greater than 40%. At the observatory of the Astrophysical Institute of the Kazakhskaya SSR Academy of Sciences near Alma-Ata, a graduate student of Kiev University, S. M. Gerasimenko, carried out observations for spectral, photometric, and polarization investigations. At Yakutsk, at the Cosmophysical Institute, Yu. A. Nadubovich, Ye. A. Ponomarev, and others photographed the comet

with short-focus astographs. On April 6.7, a tail was noted as long as 25°, and m = 2^m. On April 9.6, a straight ray which had separated from the head was visible, and even on April 29.6, m = $5^m.5$. Observations were made for investigating the polarization in the head and tail.

At Kiev, the "shadow" of the nucleus was well isolated at the end of April and in May on large-scale photographs (Vsekhsvyatskiy, Churyumov). The estimates of S. K. Vsekhsvyatskiy in the V system were as follows: on April 24.8 — m = $4^m.50$; May 5.8 — $4^m.92$; May 8.8 — $5^m.42$; May 11.8 — $5^m.33$; May 15.8 — $6^m.23$. /91

On April 4 and 24, and May 4, astronomers at the University of Minnesota's observatory detected, as a result of spectrophotometry of the comet with a 30-inch reflector, an emission near 10 microns in the infrared spectral region; this emission is well known in α Orionis, θ Ceti, μ Cephei, and in the Orion nebula near Trapezium; the suggestion was advanced that this emission may be caused by silicate particles which have condensed in the cold atmosphere of late-type stars. The possibility was not excluded that processes of such a nature should have occurred in the atmosphere of the cooling planets and entered into the composition of the freezing planetary atmosphere — cometary ices. D. Milon cited a summary of observations during the period of May — August in the ALPO (Association of Lunar and Planetary Observers) Bulletin.

Near the time of the Earth passage through the plane of the comet orbit, special photography of the comet was carried out at stations of the Smithsonian Astrophysical Observatory in order to detect an anomalous tail; however, no traces of anomalous phenomena were observed, which indicates the absence of meteoric

particles of significant sizes. During this period, the comet tail was traced as far as 15° (Roemer). On May 23 — 28, C = 2°.5 (Waterfield).

Already, on June 6.9, the comet had m = 7^m and C = 15' at position angle 25° (Lucas, Berlin). Towards June 30, the comet faded to $8^m.1$ (Bortle) or even to $8^m.9$ (Betin); however, towards the middle of July, it increased in brightness to $8^m.2$ — $8^m.3$ (Bortle, Betin).

On June 1, E. Roemer photographed, with the large 229-cm reflector, a nuclear condensation of $15^m.0$, located asymmetrically in the bright coma in which narrow rays were distinguished as far out as 1' in the northwestern quadrant. On June 2, h = $15^m.5$, and the nuclear condensation was separated from the coma (D ~ 0'.5), which was asymmetrical with respect to the nucleus.

On July 15.0, Waterfield estimated m = $10^m.5$, and the comet had a broad, curving, fan-shaped tail at p = 310°; on August 31.9, m = $12^m.0$, and the tail was already not noticeable; on September 23.9, m = $12^m.8$ without a tail. According to Seki's estimate, m = 11^m on July 25.7 and 26.8.

The most numerous series of position observations during the July — October, 1970, were obtained by Mile, Mrkos, Waterfield, Antal, and others. On November 25, E. Roemer, using the 229-cm reflector, photographed a sharp, almost stellar nucleus of h ~ $18^m.1$, surrounded by traces of a coma. The last observation was on February 27, 1971.

Literature. IC, Nos. 2196 — 2207, 2213 — 2219, 2223 — 2238, 2258 — 2265, 2271 — 2273, 2278 — 2285, and 2293; KTs, Nos. 95 — 110, 112, 115, and 117 — 118; Sky and Telescope, Vol.

39, Nos. 2 and 5; Vol. 40, Nos. 3 and 6; PASP, Nos. 487, 489, and 491; ALPO Bulletin; Bulletin of the Skalnate Pleso Observatory.

The last orbit was by B. Marsden on the basis of 153 observations from December 30, 1969, to April 10, 1970, taking into account the perturbations from all the planets: T = March 20.04586, q = 0.5376179, e = 0.9962715, and P - 1731.4 years (IC, No. 2234). /92

The preliminary values of H_{10} were: $5^m.0$ (Candy), $4^m.5$ (Vsekhsvyatskiy), and $5^m.0$ (Marsden). Elias (Athens Observatory) found (IC, No. 2321) the photometric parameters on the basis of 112 brightness estimates during the period from December 28, 1969, through September 23, 1970, to be n = 4.6 ± 0.4 (y = 11.5), H_{10} = $4^m.3 \pm 0^m.05$. From the entire collection of photometric observations and estimates (see Table 2), $H_{10} = 4^m.2 \pm 0^m.01$ was derived (Vsekhsvyatskiy, Demenko); the photometric parameters for the pre-perihelion portion of the orbit were $H_y = 4^m.5$, y = 13.7; after perihelion, H_y = 3.9, y = 9.4.

The maximum value of the head diameter was D_1 = 4'.4 (first ten days of April); at the end of August and in September of 1970, 11 — 8'. The main tail of the classic Type II was accompanied for several days by an exceedingly active Type I tail and the formation of streamers of Type I from the main elements of the Type II tail along its entire front edge. The maximum length of the main tail in the orbital plane was S = 0.39 a.u. (April 6, 1970); on isolated days, the Type I tail was of such a length. The initial repulsive acceleration for the period of April 2 — 4 appeared to have been within the range of several hundreds to several thousands in units of 1 + μ (Vsekhsvyatskiy, Demenko).

For communications about the comet spectrum, see IC Nos. 2228, 2229, and 2232; Sky and Telescope, Vol. 40, No. 3; PASP, No. 487. On April 2, 1970, the comet was scanned in L_α light by means of the OGO=5 orbital spacecraft; the existence in the comet was established of an envelope of hydrogen 8° x 10° luminous in L_α which exceeded, by a factor of 10, the dimensions of the Sun (PASP, No. 487).

r and Δ: December 25, 1969 — 1.76, 1.75; January 4, 1970 — 1.60, 1.68; February 3 — 1.11, 1.49; February 23 — 0.78, 1.21; March 15 — 0.56, 0.81; April 4 — 0.64, 0.76; April 24 — 0.94, 1.19; May 14 — 1.27, 1.66; June 3 — 1.59, 2.05; June 23 — 1.89, 2.35; July 13 — 2.18, 2.56; August 12 — 2.60, 2.75; September 11 — 2.99, 2.84; October 11 — 3.36, 2.95; November 10 — 3.71, 3.18; December 20 — 4.16, 3.78; January 29, 1971 — 4.60, 4.63; March 10 — 5.01, 5.49.

1970 III — 1969b

This was a new faint comet discovered in the constellation Vulpecula by Kohoutek on negatives of the Schmidt telescope of the Hamburg-Bergedorf observatory (80/240 cm) in the course of the completion of a program of supernova searches. Kohoutek found the coordinates $\alpha = 19^h44^m.6$, $\delta = +26°48'$ for July 24.00,1969; $m = 14^m$, and the comet was diffuse with a central condensation and a small tail 1' in length.

The comet slowly moved to the northwest, and from the beginning of August, it was widely observed with medium-sized telescopes. N. S. Chernykh, at the Krimean [illegible]rophysical Observatory, determining position on August 4 — [illegible], noted a star-like nucleus of 14^m without the characteristics of a coma and a short, narrow tail at p = 170°. Beginning August 4, an abundant /93

series of observations was obtained by Mile (Nice), Antal (Skalnate Pleso), Waterfield (Woolston), and Seki (Kochi). On August 4.9, B. Mile noticed a very sharp condensation, on August 8.9, he observed the comet to be diffuse, and on August 12.9, he observed it in the form of a diffuse coma with a condensation.

Only a continuum was noticed in the comet spectrum on plates taken by Kohoutek with an objective prism at a dispersion of 580 Å/mm near H-γ on July 26 and August 8, but emissions were not detected within the limits of 3600 — 6700 Å. Waterfield mentioned abrupt significant variations in the comet shape: on August 5.9, the comet was compact and circular, D = 25" with sharp edges and a bright eccentric nucleus was resolved; on August 6.9, D = 45", and the comet was diffuse and irregular in shape with a faint nucleus; on August 7.9, D = 50", and the comet was diffuse with a short tail (p = 145°); on August 19.9, D = 20", and the shape was the same as on August 5. In August and September, the comet was observed by a graduate student of Kiev University, S. I. Gerasimenko, with the 50-cm telescope of the Alma-Ata Observatory: $m = 13^m.5 — 14^m$. On September 4, according to Seki, $m = 13^m.5$; Mile observed a tail 3' in length, D ~ 15", and two straight, narrow streamlines at p = 150° (90") and 140" (60") on September 5.84. In October, according to Mile, the coma was 20"; on October 13.8, $m = 9^m$. According to Seki and Waterfield, $m = 11^m.5 — 12^m$ in November. On October 11, Roemer found, with the 154-cm Catalina telescope, $h = 16^m.2$ on a short exposure, and a tail of 1°.5 curved and structureless on a 30-minute exposure.

On November 27.8, Afanas'ev and Vsekhsvyatskiy photographed the comet with the 50-cm Schmidt telescope of the Byurakan Observatory. The comet had a brightness of $11 — 12^m$ with a fan-shaped tail (p = 70 — 120°) and a ray 3' in length at p = 110°.

The comet increased in brightness from $13^m.0$ to $12^m.1$ from November 1 until December 4, according to Waterfield; at this time, D ~ 25", and there was a faint tail 90 — 30" in length (p = 128°).

On Janury 8 and 9, 1970, Ts. Seki found m = 12^m, but on January 15.9 — 10^m; on February 2.8, T. Urata (Nikhondaira Observatory) estimated m = 10^m. A series of accurate positions were obtained by Kohoutek from October, 1969, through March, 1970, at the Hamburg-Bergedorf Observatory; in May of 1970, he again took objective spectrograms of the comet which indicated only a continuum from λ 3600 to λ 6700 Å. In 1970, the comet passed through the constellations Cygnus, Cepheus, Cassiopeia, Camelopardalis, Lynx, and Auriga (June). After its emergence from conjunction with the Sun, it was observed on October 1, 1970, by E. Roemer on a 22-minute exposure (154-cm reflector); the comet appeared as a sharp condensation of $17^m.5$ at the vertex of a fan-shaped coma. At this time, the comet crossed from Hydra through Pyxis and Puppis into the constellation Canis Major.

A summary table of the brightness estimates along with values of lg r and lg Δ and the reduced values of H_{10} permits establishing the periods of outbursts and increase in the comet brightness.

A summary of estimates of the integral brightness of Comet Kohoutek is given in Table 4.

The observers are: Antal (An), Afanas'ev (Af), Bortle (Bo), Van Biesbroeck (VB), Vsekhsvyatskiy (Vs), Kohoutek (Ko), Larkom (La), Mile (Mi), Morgan (Mr), Roemer (Roe), Rims (Ri), Seki (Se), Waterfield (Wa), Urata (Ur), and Chernykh (Che).

TABLE 4

BRIGHTNESS ESTIMATES OF COMET KOHOUTEK

Mean time of the Observations	m_1	Observers	lg r	lg Δ	H_{10}
1969					
July 24.0	14^m	Ko	0.527	0.406	$6^m.7$
31.9	14	Ko	.522	.404	6.8
August 3.9	14	Ko	.516	.403	6.8
4.5; 4.9	15, 14, 15	Mi, Che, Se	.515	.403	6.8 — 7.8
5.8; 5.9	14	Che, Ko	.514	.403	6.9
8.9	14.5	Mi	.514	.402	7.3
11.8	14	Che	.510	.401	6.9
12.9	14	Mi	.505	.401	7.0
13.5	15	Si	.504	.401	7.0
14.0;14.9	15	An, Se	.503	.400	7.0
17.8;18.1	14;13.5	Mi, VB	.501	.400	7.0;6.5
19.9	14	Mr,Mi	.498	.400	7.0
25.1	14	Mi	.489	.398	7.2
September 3.5	14;14.0	Se,La	.478	.401	7.2;7.2
4.6	13.5	Se	.474	.402	6.8
21	12.8	Bo	.454	.410	6.2
October 1.8	13.0	Wa	.438	.415	6.5
8.1	13.5	Ri	.428	.419	7.1
11.1			.424	.420	10.0
14.8	12.8	Roe	.420	.422	6.5
29.8	12.6	Wa	.412	.423	6.3
November 3.7	12.5	Wa	.405	.426	6.9
7.1	12.5	Af, Ri	.388	.426	6.2;6.5
13.2;14.8	13	Af	.375	.426	7.1
27.8	11, 12	Vs	.356	.425	5.9
29.8	12.4	Wa	.353	.425	6.7
December 4.8	12.1	Wa	.342	.424	6.6
1970					
January 4.8	12.5	Wa	.297	.366	7.9
February 2.8	10	Ur	.260	.300	5.9
October 1	(h = 17.3)	Roe	0.470	0.537	10.0

Literature. IC, Nos. 2156 — 2158, 2174, 2179, 2199, 2204, 2210, 2217, 2233, 2278, 2286; KTs, Nos. 86 — 91, 93 — 97, 100, 101, 103, 105, 108, 116; Sky and Telescope, Vol. 38, No. 6; PASP, Nos. 482, 484, 488, 489, and 490.

The first orbits were calculated by G. Kastel' (Institute of Theoretical Astronomy), B. Marsden, and M. Ya. Shmakova (Institute of Theoretical Astronomy); they appeared rather similar to one another (KTs, Nos. 87 and 89) and to Marsden's elliptical orbits.

During the period of July 23 to October 1, 102 observations were carried out, taking into account perturbations, and gave: T = March 21.6329, 1970, q = 1.718997, e = 0.999097, and P ≈ 70,000 years (IC, No. 2199).

Initial values of the comet absolute magnitude H_{10} were: $6^m.7$ (Kastel' and Shmakova), $7^m.5$ (Marsden). On the basis of the summary of brightness estimates (Table 4), $H_{10} = 6^m.8 \pm 0^m.02$, based on 32 independent estimates during the period of July 24, 1969 to October 1, 1970. The variation in the brightness agrees well with the law y = 10 (n = 4.0).

r and Δ: July 17, 1969 — 3.44, 2.55; August 7 — 3.26, 2.43; August 27 — 3.06, 2.50; September 26 — 2.79, 2.59; October 6 — 2.70, 2.63; October 26 — 2.53, 2.68; November 15 — 2.36, 2.67; December 5 — 2.20, 2.59; December 25 — 2.05, 2.43; January 14, 1970 — 1.93, 2.23; February 3 — 1.83, 2.00; March 10 — 1.74, 1.78; April 4 — 1.73, 1.86; September 11 — 2.76, 3.51; October 21 — 3.12, 3.37; November 30 — 3.50, 3.17; January 9, 1971 — 3.87, 3.21; and March 30 — 4.59, 4.40.

1970 IV — 1970h

In this fourth return of the short-period Comet Johnson (1949 II, 1956 V, and 1963 IV), it was rediscovered by E. Roemer and K. Elliot with the 154-cm reflector of the Catalina station on July 5.44, 1970. The coordinates for the moment of discovery are $\alpha = 1^h43^m$, $\delta = -2°$[illegible]' (constellation Cetus); this corresponded

to a correction to the ephemeris of Vorob'ev of $\Delta T = -0^d.4$ and $+0^d.4$ to the ephemeris of Beyer-Julian. Roemer estimated the nucleus to have a brightness of $m_2 = 18^m.8$; the comet was diffuse with a central condensation and a small tail 0'.1 in length.

The comet was observed by E. Roemer on October 3, 1970, with the 229-cm reflector on Kitt Peak. On a 30-minute exposure, a sharp nuclear condensation ($m_2 \sim 20^m.1$) was distinguishable only with difficulty and traces of a narrow tail out to 0'.2 ($p = 60°$) were barely noticeable. This indicates a weakening of the comet, since, according to the ephemeris, it should have been $1^m.5$ brighter.

Data about other observations up to June of 1971 have not been received.

Literature. IC, Nos. 2262 and 2269; KTs, Nos. 105 and 106; PASP, Nos. 489 and 490.

The elements of Ye. A. Vorob'ev (IC, No. 2236; KTs, No. 102) were T = March 30.535, 1970, q = 2.19998, e = 0.385524, and P = 6.774 years (also see BAAH, 1970).

The preliminary value of the absolute magnitude was $H_{10} = 13^m.5$ (KTs, No. 102). On the basis of the cited estimates, H_{10} may be $14^m.0$ — $14^m.2$ and S = 0.0001 a.u.

r and Δ: June 13, 1970 — 2.28, 2.36; July 13 — 2.32, 2.18; August 22 — 2.42, 2.01; October 1 — 2.55, 1.65; November 10 — 2.68, 1.78; December 20 — 2.83, 2.26; and January 29, 1971 — 2.98, 2.93.

1970 V — 1969f

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Comet Slaughter-Burnham was rediscovered by E. Roemer with the 229-cm reflector on November 4.5, 1969, at the position $\alpha = 21^h53^m$, $\delta = 12°55'$. A condensation was noted in the comet, there was a faint tail, and the brightness lay within the range $20^m.0$ — $20^m.2$. The external appearance permitted distinguishing the comet from many asteroids which showed up on the plates. Prior to this, Pereyra (Argentina) announced, in September, the discovery of a comet, but this object appeared to evidently be an asteroid. E. Roemer confirmed the rediscovery on the following night — November 5.

The following published observations also belong to E. Roemer: on October 3, 1970, an almost stellar condensation of $20^m.0$ and very faint traces of a tail to the west of the nucleus were evident on two plates taken with the Steward telescope with 30-minute exposures.

Literature: IC, Nos. 2184 and 2253; KTs, No. 92; PASP, Nos. 484, 489, and 490.

A new orbit was calculated by Sitarskiy (Warsaw) on the basis of observations of 1958 — 1959 and 1969 (IC, No. 2253). T = August 13.1106, 1970, q = 2.54325 a.u., and P = 11.6164 years.

The value calculated in advance for the absolute magnitude was $H_{10} = 10^m.6$ (Sitarskiy). On the basis of Roemer's two estimates and assuming the correction for the transition from central condensation to the entire coma to be equal to $2^m.0$, we obtain $H_{10} = 11^m.5$, which is at least $0^m.7$ fainter than the value for the 1959 apparition.

r and Δ: October 26, 1969 — 2.85, 2.32; December 5 — 2.73, 2.72; August 2, 1970 — 2.68, 3.21; October 1 — 2.85, 2.69; November 30 — 3.06, 3.21; January 29, 1971 — 3.31, 2.47; and March 30 — 3.56, 3.46.

1970 VI — 1970f

This comet was discovered by Graham White, a student at an Australian university (Barrok Point, New South Whales) in the early evening on May 18, when it was located 12° in all southeast of the Sun. Using a 12-power binoculars with an exceedingly clear sky, White saw the comet with a short tail at the very horizon setting in the bright twilight. He estimated $m = 1 - 2^m$ and $C \sim 1°$. On May 19.3 in Sydney, he estimated the approximate position to be $\alpha = 4^h45^m$, $\delta = +16°$, and a day later, the comet was visible to the naked eye with a tail 10° in length. Several hours after White's communication, information was received at the International Center concerning an independent discovery of a comet of 1^m on May 21 in the constellation Taurus. The comet was noticed by Emilio Ortiz, the second pilot of an Air France airplane during a flight over the Indian Ocean, 500 km east of Tananarive; the comet tail, about 8° in length, was directed towards the constellation Orion. On this same evening, May 21, but eight hours later, in agreement with the longitude difference, the comet was independently noticed in Chile by Carlos Bolelli, the night assistant at the Inter-American Observatory of Cerro Tololo, when the head had almost set, but the tail was nicely visible above the horizon. On May 22, he estimated $m = 1^m$. On the following evening, May 22, the comet was independently dis- /97
covered at the Joint European Observatory in Chile at LaSilla by G. Mayttsen and Schuster, as well as at El Roble (the Soviet Chilean station) by Potter and others. However, their names (according to the rule to cite only the first three persons who

have sent communications to the International Center at Cambridge) were not included in the comet name. At LaSilla, the first photographs of the comet were obtained, and its position was determined. On the basis of these data, Marsden established that the new comet belonged to the family of comets having small perihelion distances (the Kreutz group). The comet was independently discovered by the well-known amateur astronomer Gerber (Argentina) on May 22.9, who observed a tail 15° in length and by George Balseyro Savio (Uruguay) on May 23.9, when the tail was visible out to 20° but the brightness of the head fell to $3 - 4^m$. On this same evening, Stewart, near Wellington (Australia) independently discovered the comet, having estimated C = 10°. Then the well-known observer A. Jones found $m = 4^m$ and a tail 10° in length (p = 120°) which was weakly curved. On May 24.2, the tail was very narrow near the head (p = 115°), and later, spread out and became more diffuse.

On May 30.3, V. Fisher (Carter Observatory) saw a tail no less than 7° with a pair of binoculars, but the brightness of the head was fainter than 5^m. Matchett, Jones, and MacMillan, who independently discovered the comet on May 22 (Australia), estimated C = 3°.5 — 7° (p = 108 — 115°) on May 31.3 and June 1.3, 2.3, and 3.3; however, the tail was only 0°.4 — 0°.1 (p = 120°) already on June 4.3 and 5.3. The comet did not emerge from its proximity to the Sun, and in July, the distance was 19° in all. Accurate positions of the comet were determined by K. Bolelli (Cerro-Tololo), Harris, and Candy (Perth Observatory), Pereyra (Argentina, Cordoba Observatory), and others. For the first time, the estimates of the head integral brightness were $m = 5^m$ (Matchett), and $m = 4^m$ (MacMillan) on May 22.3; 3^m (Pereyra) on May 24.9; and 5^m on May 26.4 and a tail 15° in length, but on June 3.4, $m = 9^m$ and a tail 3° in length (Smithsonian station at Bumera), $m = 5^m.6$ on June 1.3 and 2.3 (Australian

amateurs), m = $8^m.0$ (nucleus ?) and a tail > 2° in length on June 5.9, and m = $8^m.5$ (Pereyra) on June 6.9. On June 7.3, the comet appeared only as a faintly defined nebulosity (Jones, New Zealand).

Irregardless of the fact that, according to the ephermeris, the comet might have a brightness of 18 — 19^m in August — September, when it should have emerged into the morning sky, it was not observed further.

Literature. IC, Nos. 2246 — 2253, 2259, 2261, and 2277; KTs, Nos. 104 and 105; Sky and Telescope, Vol. 40, Nos. 1 and 2; PASP, Nos. 488 and 489; ALPO Bulletin.

The first orbit was calculated by B. Marsden (KTs, No. 104), who suggested its belonging to the family of comets having small perihelion distances (Sun grazers) investigated by Kreutz and in our time — by Marsden. This suggestion was completely confirmed (IC, No. 2261). T = May 14.486, 1970, q = 0.008879, and i = 139°.06.

The preliminary value of the absolute magnitude was H_{10} = $6^m.5$ (Marsden). The ephermeris based on Marsden's elements was calculated by A. A. Demenko (KTs, No. 105). The estimates (21) cited in the description, which were made under very difficult conditions when the comet was near the horizon in the bright twilight sky, gave $H_{10} = 5^m.7 \pm 0^m.3$. The law y = 10 gives completely satisfactory agreement with the observations within the limits of variation of lg r from -0.43 to -0.10. /98

Only at the beginning of June was a decrease noticed in the comet absolute brightness, which it is completely possible was the result of not taking adequate account of the effect of the bright background and absorption in the Earth atmosphere.

The dimensions of the head were estimated from photographs taken May 23.98 by Mayttsen, Moffat, and Schuster, cited in Sky and Telescope, Vol. 40, No. 1; D_1 = 6'.7. For this same date for which, according to an estimate C = 15 — 20° (from the photographs C ~ 13°, but it is possible that it was traced further with the naked eye), we obtain S = 0.58 — 0.88 a.u. (the angle K = 51°). Juding from the photographs, the main tail was of Type II, of the same nature as the tail of Comet Ikeya-Seki (1965 VIII) (composed of mineral particles "blown off" as a result of ablation from the surface of the meteoric masses of the nucleus upon passage through the solar corona). Traces of a Type I tail significantly fainter and no more than 0.22 a.u. in length were noticable on a photograph of the comet.

r and Δ: May 18, 1970 — 0.36, 1.19; May 23 — 0.51, 1.33; May 28 — 0.62, 1.45; May 30 — 0.67, 1.51; June 3 — 0.79, 1.63; June 7 — 0.89, 1.75; and June 11 — 0.99, 1.86.

1970 VII — 1970d

E. Roemer and Schruer (Lunar and Planetary Laboratory) rediscovered, using the 229-cm reflector at Kitt Peak on March 14, 1970, Comet D'Arre in its twelfth observed apparition (the 19th return to perihelion after its discovery in 1851); the comet was diffuse with a condensation of $19^m.5$ at the position $\alpha = 15^h58^m$, $\delta = -9°02'$, near Marsden's ephermeris based on a new orbit; prior to this, the comet was not found on March 7 and 8 with the 154-cm reflector.

The comet moved rather rapidly through the constellations Aquarius and Pisces along the ecliptic, and on May 18, it passed through perihelion; in June — August, it passed through the northern region of the constellation Cetus and crossed Taurus;

at the end of the year, it was slowly moving in Orion. On May 7.46, Roemer and McKallister observed a central condensation with h = $17^m.d$, d = 0'.1; the faint coma was several times larger, the comet images were "soft," and it was diffuse. In June, the comet integral brightness increased significantly. On June 1.77, Seki estimated m = 13; on June 8.76, Urata (Nikhondaira, Schimitsu, Shizuoka) observed the comet visually with a 20-cm reflector at 50 x and found m = 11^m, D = 3'. This short-period comet caused special interest in connection with the suggested launch in 1975 of the space probe to it.

On June 7.45, Roemer observed a central condensation with the Catalina reflector (154-cm); the nucleus was not exactly star-like, having a diameter of 6" and h = $17^m.4$. E. Roemer saw the comet in the 6-inch finder as a diffuse trace of 11 — 12^m with D ~ 1'; photographs again showed a non-stellar nucleus of 16^m surrounded by a large coma.

R. White, using the Steward reflector at Kitt Peak, obtained /99 spectrograms of the comet on July 9.4 and 10.4, using an image-converter tube on a spectrograph at the Cassegrain focus: the strongest emission against a faint, continuous spectrum appeared to be the 3883 CN band, then 4050 (C_3), 5165 and 4737 (C_2), and also traces of 4201 (CH) and 3090 (OH).

On July 15.78, Ts. Seki estimated m = 11^m. On September 26, E. Roemer photographed the comet with an almost stellar nucleus of $19^m.6$ near the apex of a poorly defined fan-shaped coma out to 0'.3 to the northeast. Two months later, on November 26, Roemer detected, on a 60-minute photograph, a sharp, almost stellar nucleus with h = $19^m.5$ and traces of a coma; this indicated a significant increase in the comet absolute brightness after perihelion. The last observation was on January 20, 1971.

Literature. IC, Nos. 2191, 2227, 2254, 2260, 2267, and 2283; KTs, Nos. 101 and 105; PASP, Nos. 487, 488, 489, 490, and 491; ALPO Bulletins.

The orbit was calculated by B. Marsden on the basis of 80 reviewed observations during the apparitions of 1923, 1943, 1950 (taking into account the perturbations from all the planets), and 1967; T = May 18.435, 1970 (precalculation), q = 1.16680, and P = 6.235 years (IC, No. 2191; KTs, No. 101).

The preliminary value of h_{10} for the central condensation was $15^m.5$, and the integral magnitude according to B. Marsden's suggestion should have reached 11^m in May of 1970 (i.e., $H_{10} = 9^m.5$).

On the average, $H_{10} = 9^m.5 \pm 0^m.1$ was obtained from the five high brightness estimates during the period of the comet brightness rise after perihelion, which is in good agreement with B. Marsden's prediction. $h_{10} = 15^m.9 \pm 0^m.3$ for the brightness of the nucleus; increases or outbursts of the comet brightness were noted on about June 7 and the end of November. $D_1 = 1'.6$ (maximum reduced emissions of the comet), and $d_1 = 0'.1 — 0'.2$ (central condensation).

See IC No. 2267 and PASP, No. 489, concerning observations of the spectrum.

r and Δ: March 15, 1970 — 1.42, 1.75; April 24 — 1.21, 1.49; May 14 — 1.17, 1.46; June 3 — 1.18, 1.57; July 13 — 1.36, 1.55; August 22 — 1.65, 1.56; October 1 — 1.97, 1.49; November 10 — 2.29, 1.44; and November 30 — 2.45, 2.52.

1970 VIII — 1970b

This was the seventeenth observed apparition and the twenty-seventh return to the Sun of Comet Pons-Winnecke after its discovery in 1819. E. Roemer, who together with MacKallister photographed it on February 3.49, 1970, with the 229-cm telescope, rediscovered the comet. The region was near the ephermeris position based on the calculations of Marsden and Aksnes ($\alpha = 13^h26^m$, $\delta = +24°39'$); the comet appeared star-like with a nucleus of $19^m.8$. After its rediscovery, the comet was detected on a plate of January 11, on which the brightness of the central condensation was estimated to be $h = 20^m.5$. Based on Roemer's observations, the almost stellar condensation was $18^m.8$ on March 7; March 13 — $18^m.8$, and traces of a coma on the southwest side; and on April 7, $h = 18^m.2$ and practically star-like with the 154-cm reflector.

After its discovery, it moved in the constellations Coma Berenices and Canis Venatici, having reached the 42° north parallel at the end of April; in June and the beginning of July, it rapidly dropped southward and crossed the celestial equator, moving into the constellation Virgo. At this time, it passed through perihelion and should have been 2^m brighter than it is discovery. Accurate positions were obtained at the Klet' Observatory in Czechoslovakia (Mrkos) and at the Perth Observatory in western Australia (Harris, Gans); thus, m could not have been fainter than 15 — 16^m. /100

On June 7, E. Roemer found $h = 17^m.8$ and an almost stellar object on a 10-minute exposure; it was observed visually as a sharp condensation with traces of a coma. On July 6, it was still sharply condensed and $h = 17^m.0$. In August — September, it dropped to the 45° south parallel, passing through the constellations Libra and Scorpius, and in October, it moved along the boundary of the constellations Telescopium, Corona Australis,

and Sagittarius. E. Roemer, using the Catalina telescope, found on a pair of 40-minute photographs taken November 1 h = $17^m.7$ and a faint and more diffuse image than star images but indicating a certain degree of central condensation.

Literature. IC, Nos. 2185, 2206, and 2278; KTs, No. 105; BAAH, 1970; PASP, Nos. 485, 487, 489, 490, and 491.

The orbit was by B. Marsden and K. Aksnes on the basis of 120 observations from March 17, 1939 to October 8, 1964, and taking into account perturbations from all nine planets. T = July 21.027, 1970 (precalculated), q = 1.24738 a.u., and P = 6.344 years.

The photometric parameters used by B. Marsden in his precalculation were y = 15, $H_y = 13^m.0$, and $h_y = 15^m.5$.

On the basis of the cited estimates, $h_{10} = 15^m.9$; during the first period of observati[illegible] $15^m.2$, and in June — November, $16^m.7$. The integral absolute magnitude H_{10} was not determined, but it was evidently fainter than 14^m. The comet was possibly found at the threshold of exhaustion, since it did not correspond at all to precalculated values; the following results were obtained in the preceding apparitions: 1964 I, $h_{10} = 15^m.1$, $H_{10} = 13^m.5$ — 14^m; 1945 IV, $H_{10} = 12^m.7$.

r and Δ: January 14, 1970 — 2.37, 1.19; February 3 — 2.22, 1.58; March 15 — 1.92, 1.08; April 24 — 1.62, 0.83; June 3 — 1.38, 0.71; July 13 — 1.25, 0.66; August 22 — 1.31, 0.79; Octob[illegible] 1 — 1.51, 1.15; and November 10 — 1.80, 1.68.

1970 IX — 1970k

This was the second observed apparition of Comet Jackson-Neujmin (1936 IV). It was discovered after a 34-year interruption in the observations on the basis of a new system of elements and Marsden's ephermeris with a correction ΔT amounting to -7^d in all. It was discovered in 1936 and received the designation 1936 IV (P = 8.6 years); It was missed upon the returns in 1945, 1953, and 1962. A successful precalculation under such conditions is undoubtedly a great achievement in the theory of the motion of short-period comets. /101

Comet Jackson-Neujmin was discovered by Ch. Kowal on a plate of the Palomar 122-cm Schmidt telescope on September 6.44, 1970, at the position $\alpha = 4^h$, $19^m.9$, $\delta = +7°21'$; m_1 (integral brightness) was 14^m. The comet was found in Taurus and was moving by the end of the year in Orion. According to Kowal, it was diffuse with a central condensation and a small tail. The comet was observed by Ts. Seki (Kochi) on September 23.78 and 26.78, and on September 29 — 30, it was observed by A. Mrkos; Seki estimated it to be 16^m.

On October 1, although it was faint but distinct, it was seen by E. Roemer with the 154-cm Catalina reflector (15 — 16^m ?); there was a sharply condensed, but non-stellar nucleus on the plates, and it had h = $18^m.7$. On October 5, the pronounced condensation appeared better with the 229-cm reflector, being found at the apex of a fan-shaped coma, and h = $18^m.5$. A subsequent observation by E. Roemer on October 31 with the 154-cm reflector revealed a well-condensed nucleus of $18^m.4$, surrounded by traces of a coma; on November 25, with the 229-cm telescope, an essentially stellar nucleus of approximately $19^m.4$ surrounded by a large coma out to 0'.4 was found on a 60-minute exposure.

Literature. IC, Nos. 2240, 2277, and 2282; KTs, No. 107; PASP, Nos. 490 and 491.

The orbit was by B. Marsden and was based on 33 observations from September 9, 1936, to November 5, taking into account the perturbations from all the planets; in 1956, it approached Jupiter to within 0.8 a.u. Marsden's new elements, which take into account the first observations of 1970, changed T by -7^d and introduced small corrections into the other elements, although the period was practically unchanged (IC, Nos. 2240 and 2277); T = August 6.4272, 1970, q = 1.42801 a.u., and P = 8.394 years.

B. Marsden suggested $H_{10} = 16^m.5$ after a review of the brightness estimates at the 1936 apparition; $H_{10} = 13^m.3$ for 1936 IV in Vsekhsvyatskiy's catalogue of absolute magnitudes of comets. On the basis of the estimates of Ch. Kowal and Ts. Seki (a weight of 0.3), $H_{10} = 13^m.4$; the absolute magnitude of the nucleus or central condensation was, according to E. Roemer's estimates, $h_{10} = 17^m.0$, and $D_1 = 0'.4$ — $0'.8$, and S = 0.0004 a.u. (?).

r and Δ: September 1, 1970 — 1.44, 0.84; September 11 — 1.42, 0.82; October 1 — 1.53, 0.80; October 21 — 1.63, 0.80; November 10 — 1.74, 0.84; and November 30 — 1.87, 0.94.

1970 X — 1970m

The director of the Tokyo Observatory, Hurukawa, communicated by a telegram sent to B. Marsden the discovery on October 19.41, 1970, of a comparatively bright comet by two Japanese observers — Suzuki and Ya. Sato. Suzuki estimated it to be 6^m; Sato estimated it to be 8^m and diffuse, without a central condensation and without a nucleus or tail.

The comet was discovered in the evening sky southwest of δ Ophiuchus, and it was moving away from the Sun along the boundary between Ophiuchus and Hercules; in the middle of November, it passed not far from α Ophiuchus.

On October 20.4, it was independently discovered by Ts. Seki and A. Tago (Kochi Observatory) and, as it was explained later, already on October 19.4 by Kobayasi. On October 21.41, Tomita made determinations of accurate positions of the comet and noted a tail longer than 1°. Later on, Seki, Mile, Elias, Kozia, Tomita, Waterfield, Chernykh (Krimean Astrophysical Observatory), Antal, Mrkos, Belitskiy, Pil'skiy, and others observed the comet. Brightness estimates and a description of distinctive features of the comet were made by observers of the cometary section of ALPO. All estimates of the brightness, diameter of the head, and length of the tail accessible at the present time are collected together in Table 5. /102 /103

The observers were: Antal (An), Bakharev (Ba), Jones (J), Kozai (Ko), Lambert (La), Lukas (Lu), Milon (Ml), Matchett (Ma), Mile (Mi), Miller (Me), Mrkos (Mr), Roemer (Roe), Sato (Sa), Switzer (Sw), Seki (Se), Suzuki (Su), Tomita (To), Waterfield (Wa), Chernykh (Che), and Elias (E).

The values of D_1 were: October 22.73, 1970 — 5'.4; October 25.57 — 2'.2; November 1.05 — 2',2; November 26 — 0',5; and on October 21.40, C = 1°.

It is possible to distinguish from this series of observations the periods of October 22.4 — 24.4 and 27.31, when a rise in the comet brightness by 1^m — $0^m.3$, the first of these outbursts undoubtedly being real; precisely during this period, Lucas and Miller, observers of the ALPO, noted a large diameter

TABLE 5

BRIGHTNESS ESTIMATES OF COMET SUZUKI-SATO

Mean Time of the Observations	m_1	Observers	r	Δ	lg r	lg Δ	H_{10}
1970							
October 19.41	$6^m.8$	Su, Sa	0.61	1.06	-0.215	+0.025	$8^m.0;10^m.0$
20.38	8.7	Sa, Se	.63	1.06	.202	.025	9.0;8.9
21.38	7;7.4	To,J,Ma	.64	1.07	.194	.030	8.8;9.2
21.40-41	7;7.6	To,Se	.64	1.07	.194	.030	8.8;9.4
21.76	7.4	Mi	.65	1.07	.187	.030	9.1
22.38	7.9	J	.66	1.08	.180	.034	9.5
22.40	7	Ko	.66	1.08	.180	.034	8.6
22.70	7.0	Che	.67	1.08	.174	.034	8.6
22.73	6.7	E	.67	1.08	.174	.034	8.3
23.59	7.3	Ba	.69	1.09	.162	.036	8.7
23.75	7;7.1	Mr,Lu	.69	1.09	.162	.036	8.4;8.5
24.58	7.5	Ba	.71	1.10	.150	.041	8.9
25.11	7.2	Me	.72	1.10	.172	.041	8.5
25.57	7.9	Ba	.73	1.10	.137	.041	9.7
26.03	7.5	Sw	.74	1.12	.130	.043	8.6
26.39	8.3	Se	.75	1.12	.126	.045	9.3
27.38	8.2	J	.71	1.12	.120	.045	9.2
27.40	7	To	.76	1.12	.120	.049	8.0
28.01	7.6	Mi	.77	1.13	.114	.053	8.5
28.38	8.1	J	.77	1.13	.114	.053	9.0
28.58	7.8	Ba	.78	1.13	.108	.053	
28.76	7.0	Wa	.78	1.13	.108	.053	8.6
29.40	8.4	Se	.79	1.14	.102	.057	7.7
29.58	7.8	Ba	.79	1.14	.102	.057	9.1
30.40	8.6	J, Se	.79	1.15	.102	.057	8.5
30.57	7.3	Ba	.81	1.16	.093	.065	9.3
31.39	8.7	J	.83	1.16	.081	.065	8.0
Nov. 1.05	7.5	Sw	.85	1.17	.070	.068	8.4
1.68	8	Che	.86	1.18	.066	.072	9.2
3.04	8.9	La	.88	1.19	.056	.078	
4.40	9	Se	.90	1.21	.046	.083	9
5.76	8.5	Wa	.93	1.23	.032	.090	8.4
7.59	9.0	Ba	0.96	1.26	-0.018	.100	8.7
11.39	10	Se	1.04	1.30	+0.008	.114	9.2
12.69	11	An	1.04	1.31	.018	.116	10.2
15.67	10-11	Che	1.11	1.36	.046	.134	8.9
16.41	12	Se	1.14	1.38	.057	.140	10.7
26	11	Ba					
	15?	Roe	1.31	1.53	+0.117	+0.184	13?

of the coma, which reached 5'. Almost at the same time, Kozai noted, on October 22.4, a tail of the comet longer than 1°.

The comet rapidly faded and, as is evident from Table 5, had already by October 29 lost 1^m, and in five more days, had dropped to 9^m, and by the middle of November, to 12^m. E. Roemer noted that, from the beginning of November, an increasing diffuseness of the comet was detected; even so, the comet at this time had $m_1 = 8^m.5 — 9^m$ and was easily visible in the 15-cm finder of the Catalina station reflector. On a photograph taken November 2, its image was large and almost without a central condensation, while the level of central intensity corresponded approximately to stars of 16^m on November 26. Roemer saw the comet with exceptional difficulty in the 229-cm reflector (Kitt Peak), as it was so diffuse, although the sky was completely dark; only a coma of 0'.5 almost without a condensation appeared on a 10-minute exposure. The last time it was observed was on November 30, 1970.

It is certain that the comet rapidly disintegrated, similar to what occured in the case of Comets 1874 I, 1954 II, and others.

Literature. IC, Nos. 2283 — 2285, 2288, 2292, 2298, 2302, and 2307; KTs, Nos. 110 — 113; PASP, No. 491; Sky and Telescope, ALPO Bulletins.

Preliminary orbits were calculated by K. Hurukawa and G. Kastel' (Institute of Theoretical Astronomy), which agreed in setting perihelion as October 1 at a distance of q = 0.4 a.u. B. Marsden (IC, No. 2288) calculated an orbit from an arc of ten days, while G. Kastel' (KTs, No. 111) did so from a 24-day arc; all these elements were very close to one another and to the elements of Ts. Seki, who had determined a weakly hyperbolic eccentricity on the basis of 20 observations (IC,No. 2302).

The preliminary values of the absolute magnitude H_{10} were as follows: $9^m.0$ (Hurukawa), $8^m.7$ (Kastel'), $9^m.0$ (Kastel'), and $9^m.2$ (Marsden, $h_{15} = 13^m.0$, $H_{15} = 8^m.5$).

We obtained $H_{10} = 8^m.9 \pm 0.05$, $D_1 = 5'.4$ (October 22), and S = 0.02 a.u. (October 22) on the basis of the entire collection of brightness estimates (46).

r and Δ: October 19, 1970 — 0.60, 1.06; October 25 — 0.72, 1.10; October 29 — 0.79, 1.14; November 2 — 0.87, 1.18; November 6 — 0.94, 1.23; November 10 — 1.02, 1.29; November 14 — 1.09, 1.35; November 22 — 1.24, 1.47; and November 30 — 1.38, 1.59. /104

1970 XI — 1970c

This was the tenth observed return of the short-period Comet Kopff (1906 IV) and the eleventh passage through perihelion since its discovery. It was rediscovered by E. Roemer with the 154-cm Catalina reflector on February 7.5, 1970, near the ephermeris position of Sitarskiy as a star-like object of $19^m.5$ ($\alpha = 13^h38^m$, $\delta = -4°23'$). Its discovery was confirmed on February 13 (Roemer, Latta); the comet was star-like as before with $h = 19^m.5$.

It was observed by A. Mrkos (Klet' Observatory, Czechoslovakia) and also by Candy, Gans, and Birkh (Perth Observatory, Australia). The last observation was on November 23.

Literature. IC, Nos. 2188, 2213, 2223, and 2276; KTs, No. 99; PASP, Nos. 485, 487, 489, 490; BAAH, 1970.

The elements and ephermeris were by G. Sitarskiy (BAAH, 1970; Acta Astron., Vol 18, 1968, p. 155). T = October 2.4066, 1970 UT, q = 1.5669914 a.u., and P = 6.4152 years.

The precalculated value was $h_{10} = 13^m.4$ (Sitarskiy); on the basis of E. Roemer's estimates, $h_{10} = 13^m.7 \pm 0^m.1$. It follows from the condition that the comet could not have been fainter than $14 - 15^m$ during the observations by A. Mrkos and M. Candy that H_{10} is no fainter than $10^m.5 - 11^m.5$.

r and Δ: February 3, 1970 — 2.67, 2.15; February 15 — 2.60, 1.96; March 11 — 2.46, 1.58; April 4 — 2.31, 1.32; April 28 — 2.17, 1.21; May 22 — 2.03, 1.22; June 15 — 1.90, 1.30; July 9 — 1.78, 1.40; August 2 — 1.68; 1.51; August 26 — 1.61, 1.61; October 13 — 1.57, 1.85; November 30 — 1.67, 2.20.

1970 XII — 1970d

It was discovered by N. Kojima on December 27.79, 1970, on a plate taken at Ishiki (Aichi). Upon discovery, it was found in Virgo and was moving southeastward. At discovery, it was estimated to be 14^m, and on December 29.94, it was confirmed by the same Kojima. From December 31, it was observed at the Dodiera station of Tokyo Observatory (Tomita) and at the Kochi Observatory (Seki). At first, it was estimated to be 14^m (m_1) and the nucleus — 15^m (m_2). On January 1.80 and 2.83, 1971, $m_1 = 13^m$ (Tomita). The comet was described as diffuse with a condensation or nucleus, and on December 31 (Seki) and January 2.8 (Tomita), a small tail was noted.

On January 6.78, Kozai (Tokyo Observatory, Dodiera station) found $m_1 = 14^m$, and the comet was diffuse with a condensation. On January 9.86, Kojima observed the comet and found $m_1 = 14^m$.

The first parabolic orbit was calculated by K. Hurukawa from a 10-day arc. However, after E. Roemer's observation on January 23.50, 1971 (m_2 = $17^m.3$), B. Marsden found the first elliptical orbit having a period of 6.09 years, which indicated a perihelion at the beginning of October and a probable encounter of the comet with Jupiter in 1962 (about 1.5 revolutions prior to its discovery). The discovery of the second short-periodic comet /105 during the course of the year caused great interest, and the comet continued to be intensively observed, although it was faint and accessible only tc telescopes of significant size.

According to Seki, on January 23.77 m_1 = 15^m; February 6.85 — 15^m; February 23.84 and 26.80 m_1 = 15^m; 27.79 — $15^m.5$ (Kojima); March 3.80 — 16^m (Seki); 7.81 — 16^m (Seki); 9.87 — $16^m.5$ (Kojima). The comet faded noticeably. Roemer observed m_2 = $17^m.2$ on March 27.39. The last observations was on June 27.

Literature. IC, Nos. 2298, 2300, 2303, 2304, 2307, 2313, 2315, 2316, and 2322; KTs, Nos. 113 — 115, 117, and 118; PASP, No. 492.

The orbit was by B. Marsden, based on 38 observations from December 27 to March 7. T = October 6.95, 1970, q = 1.6300 a.u., e = 0.51392, and P = 6.14 years (IC, No. 2316).

The initial values of the absolute magnitude were H_{10} = $10 — 11^m$ and h_{10} (for the nucleus, the m_2 system) = $13 — 14^m$ (Vsecksvyatskiy, KTs, No. 117) and 13^m (Marsden). On the basis of all the cited estimates, H_{10} = $10^m.6 \pm 0^m.2$ and h_{10} = $13^m.0 \pm 0^m.4$, D_1 was no smaller than 2'; and S > 0.0005 a.u.

r and Δ: December 30, 1970 — 1.80, 1.87; January 29, 1971 — 1.95, 1.68; February 18 — 2.05, 1.56; March 10 — 2.15, 1.44; March 30 — 2.26, 1.38; April 19 — 2.37, 1.38; May 29 — 2.60, 1.70; July 8 — 2.82, 2.33; and August 17 — 3.04, 3.07.

1970 XIII — 1970i

This was the second observed apparition of Comet duToit-Neujmin-Delport (1941 VII). The rediscovery of this comet, together with other cases of the recovery of "lost comets" was a triumph of contemporary computational celestial mechanics and a remarkable success for Marsden, the director of the International Bureau of Astronomical Discoveries, a well-known investigator of cometary motion. The comet was discovered on July 18, 1941, by duToit (Blumfontaine) and on July 25 by G. N. Neujmin in Simeiz, and independently on August 19 by Delport in Uccle. In spite of the wartime conditions, the comet was observed until the end of October, for three months in all; the comet was not recovered either in 1946, or 1952, or at the succeeding returns. B. Marsden introduced corrections into the advanced calculation of Sochilina for 1958, and his ephermeris was close to the comet corresponding motion; the correction to Sochilina's advanced calculation for 1958 was $\Delta T = +4^d$ in all.

The comet was rediscovered by C. Kowal, who photographed regions based on Marsden's ephermeris with the 122-cm Schmidt telescope of the Palomar Observatory; it was discovered on a plate from July 6.22, 1970, at the position $\alpha = 15^h13^m.5$, $\delta = -13°18'$, as an object of 19^m, diffuse, with a small condensation, and without a tail. On July 27.21, the comet was photographed by E. Roemer and D. Reskin, with the Steward reflector on Kitt Peak; Roemer wrote about a small and faint image whose brightness was $m_2 = 19^m.5$ (according to another communication — $19^m.8$). On

September 26, it was exceptionally diffuse under poor observational conditions. On October 5, a well-condensed, but faint image of the comet (20^m ?), the last at this apparition, was obtained on two 40-minute exposures. /106

Literature. IC, Nos. 2222, 2264, and 2269; KTs, No. 106; PASP, Nos. 489 and 490.

B. Marsden's orbit, which was calculated as a result of a review of the 72 observations of 1941, after which the comet made five revolutions, indicated an encounter with Jupiter in 1954 and 1966. As a result of a focusing effect, a condition of compensating errors arose and the comet was discovered, although it should have been 2 — 3^m fainter than in 1958. T = October 8.1642, 1970, q = 1.677050 a.u., e = 0.508677, and P = 6.306 years (IC, No. 2222).

The precalculated value was $H_{10} = 15^m.0$ (Marsden). On the basis of the four cited observations, we obtain $H_{10} = 16^m.0$ and $h_{10} = 16^m.7$ (from Roemer's estimates). Thus, in thirty years, Comet 1941 VII faded by 4^m (by a factor of 40); in 1970, just as in 1941, the dimensions of the head D_1 did not exceed 12 — 19", and no traces of a tail were observed.

r and Δ: June 23, 1970 — 1.95, 1.06; July 13 — 1.86, 1.13; August 2 — 1.79, 1.23; August 22 — 1.74, 1.34; October 1 — 1.68, 1.59; and November 10 — 1.71, 1.90.

1970 XIV — 1969c

This was the sixth observed apparition of the short-period Comet Whipple (1933 V). It was rediscovered by Z. Pereyra (Cordoba, Argentina) with the 152-cm reflector of the Bosque

Alegre station on July 20.18, 1969, at the position $\alpha = 18^h6^m.1$, $\delta = -9°33'$, exactly as predicted by the ephermeris of Marsden and Aksnes; upon discovery, it was estimated to be 19^m. The discovery was confirmed by Pereyra on August 9.10 — 9.16, when he also found $m_2 = 19^m$. The comet slowly shifted into Serpens with retrograde motion; in September, it moved eastward, and in October — November, it crossed the constellation Scrutum and the northern portions of Sagittarius.

On September 6, E. Roemer obtained an almost stellar image somewhat fainter than $20^m.5$ with the 154-cm reflector. On June 1, 1970, Roemer found $h = 19^m.0$ and a well-condensed image on a 30-minute exposure taken with the 229-cm telescope. In October, during perihelion passage, it was favorably situated in Pisces and was observed in Japan, Czechoslovakia, and U.S.A.

On September 29, 1970, accurate positions were obtained by A. Mrkos at the K_et' Observatory; therefore, one can conclude that, at this time, the comet integral brightness could not have been fainter than 15 — 16^m. On October 22.59, 1970, Seki estimated $m = 16^m$. Mrkos and Petrovicheva determined accurate positions for December 19.7, 1970, and January 18.8, 24.8, and 29.8, 1971.

E. Roemer saw the comet as a faint, diffuse trace with the 154-cm reflector on September 30, 1970; it appeared on a photograph as a very well-condensed, almost stellar image of $17^m.6$ (m_2). On October 31, Roemer, using the Catalina reflector, obtained an almost stellar nucleus of about $17^m.5$ with traces of a coma; it appeared somewhat brighter on photcgraphs taken with the Steward /107
229-cm telescope on November 29, 1970. During 1971, in the first quarter and in the second half, it was accessible for observations with large telescopes. It was observed for the last time on December 21, 1971.

Literature. IC, Nos. 2144, 2157, 2166, 2220, 2283, 2296, and 2309; KTs, Nos. 109, 113, and 115; PASP, Nos. 483, 488, 490, and 491; BAAH, 1969, 1970, and 1971.

B. Marsden's orbit, based on 120 observations of the entire period from 1933 through 1964, took into account perturbations from all nine planets and nongravitational effects (IC, Nos. 2144 and 2157); T = October 9.47114, 1970 UT, q = 2.479505 a.u., and P = 7.47 years (epoch, October 21, 1970).

The preliminary value of the absolute magnitude $H_{10} = 12^m.5$ (Marsden) was underestimated: on the basis of the cited estimates of Z. Pereyra, K. Seki, and the observations of A. Mrkos, $H_{10} = 10^m.6 \pm 0^m.3$, and based on Roemer's estimate, $h_{10} = 12^m.6 \pm 0^m.1$. The absolute magnitude of the nucleus and the comet integral brightness were maintained within the limits of accuracy of estimates at the level of the two preceding apparitions; however, in 1969 — 1970, there were no indications as to the coma structure, which might have served as a sign of the continuing disintegration of the comet [1, 2, 6].

r and Δ: July 18, 1969 — 3.56, 2.63; August 1 — 3.50, 2.72; August 27 — 3.43, 2.88; September 16 — 3.37, 3.09; May 14, 1970 — 2.65, 3.07; July 3 — 2.61, 2.81; July 23 — 2.58, 2.54; August 2 — 2.52, 2.01; September 11 — 2.49, 1.60; October 21 — 2.48, 1.49; November 30 — 2.50, 1.78; January 9, 1971 — 2.55, 2.59; February 18 — 2.62, 2.85; March 30 — 2.71, 3.35; September 6 — 3.18, 3.74; October 16 — 3.31, 3.37; and December 15 — 3.51, 2.76.

1970 XV — 1970g

This was the fifth comparatively bright new comet observed in 1970. It was discovered on July 3.73 by the Japanese amateur Abe near α Aries ($\alpha = 2^h17^m$, $\delta = +23°24'$) in the morning sky as a diffuse object of 9^m, without a central condensation and without a tail. It was confirmed by Abe on July 4 and from July 5, it was observed in Japan, Australia, where the first accurate positions were determined, and then at many other observatories.

The comet was moving almost exactly north along the 2^h hour circle; at the end of July and in the first half of August, it passed through Andromeda; in the second half of August, it crossed Cassiopeia, entering the constellation Cepheus. At the beginning of September, it passed within 16° of the north celestial pole and intersected the constellation Draco, and in September — October, it dropped southward along the 17^h and 16^h hour circles. Throughout its passage through northern regions of the sky, it reached a brightness of 6 — 5^m, was visible to the naked eye, and was widely observed by astronomers of the northern hemisphere. On July 5.78, Seki estimated m = 10^m. On July 7.45, m = 10^m with a circular diffuse coma without a pronounced nucleus; on July 12.4, Van Biesbroeck estimated m = $10^m.5$ and D = 3'.5 with a bright central condensation of 10 — 15" and without a tail (Simmons). On July 13.7 and 15.7, Urata and Seki photographed evidently only the central condensation of $10^m.5$ — 11^m, and at the same time on July 15.71, Tomita estimated m = 7^m and Bortle, on July 13 — $8^m.6$. On August 8.98, Waterfield found m = $6^m.5$; at the end of August, it increased in brightness to $5^m.5$ (Vsekhsvyatskiy), and from the beginning of September, it was observed to have a fine active tail (Miller, Mile, Harwood). On September 7, the tail length was C = 1° (Mile). On September 21.8, a diffuse

structureless forked tail appeared on a 30-minute exposure; the main branch had C = 1°.5 (p = 80°), and the fainter branch had C = 0°.5 (p = 65°); D = 5', and the denser part had d = 2', m = $5^m.5$ (Harwood, Waterfield).

A summary is given in Table 6 of the published brightness estimates of the head and central condensation (nucleus) mainly based on data of the IC, KTs, and the IAU Bulletin.

The observers were: Abe (A), Bakharev (Ba), Bielitskiy (Bi), Bettin (Bt), Bronnikova (Br), Bortle (Bo), Van Biesbroeck (VB), Vsekhsvyatskiy (Vs), Jones (J), Delano (De), Zinger (Zi), Conger (Co), Lucas (Lu), Matchett (Ma), Mile (Mi), Morris (Mo), Roemer (Roe), Switzer (Sw), Seki (Se), Simmons (Si), Sebastian (Sb), Tomita (To), Urata (Ur), Waterfield (Wa), Harwood (Ha), and Churyumov (Chu).

The values of $h(m_2)$ were: July 15.75 — 11^m, September 29.30 (outburst) — $10^m.8$, and October 3.8 — $14^m.5$.

The values of D were: July 12.4 — 3'.5; September 3.6 — 5'; September 21.8 — 5'; September 27.68 — 3'.5; and October 29.39 — 30".

The values of C were: September 7.81 — 1°; September 21.8 — 1°.5; September 27.68 — 1°.5 — 2°.0; September 28.60 — 1°.5; September 30.6 — 5 — 7°; and December 26.84 — 30'.

The values of h_{10} were: July 13.31 — $7^m.0$; September 15.96 — $8^m.3$; September 22.80 — $7^m.6$; September 26.10 — $7^m.8$; September 28.04 — $7^m.8$; October 2.02 — $7^m.5$; October 3.8 — $7^m.7$; October 7.03 — $8^m.2$; October 8.7 — $7^m.5$; and October 10.12 — $8^m.0$.

TABLE 6

BRIGHTNESS ESTIMATES OF COMET ABE

Average time of Observations		m_1	Observers	lg r	lg Δ	H_{10}
1970						
July	3.73	9^m	A	0.300	0.338	$4^m.3$
	4.73	9	A	-	-	4.3
	5.78	10	Se	-	-	5.4
	6.79	10	Se	-	-	5.5
	7.46	10	VB	-	-	5.5
	8.76	10.0	J	-	-	5.5 - 6.0
	12.28	10.0;10.5	Sw	-	-	6.2
	12.4	10.5	Si	-	-	4.8
	12.77	9.1	Ma	0.270	0.298	4.5
	13.31	8.6	Bo	-	-	3.0
	15.71	7	To	-	-	-
	15.75		Se	-	-	-
August	2.91		Br	0.222	0.150	-
	25.96	6.5	Vs	0.153	-0.057	5.3
	27.85	5.5	Vs	-	-	4.4
	27.90	5.5	Vs	-	-	4.4
	28.90	5.9	Vs	0.142	-0.082	4.9
	30.83	6.0	Vs	-	-	5.0
	31.87	6.2	Vs	-	-	5.2
September	1.82	6.5	Vs	-	-	5.5
	2.04	6.2	Si	-	-	5.3
	2.14	6.4	Bo	-	-	5.5
	2.16	6.4	Co	-	-	5.5
	2.76	6.3	Vs	0.130	-0.190	5.4
	3.6	6.7	Ba	-	-	5.8
	5.16	6.3	Bo	-	-	5.6
	6.15	6.1	Bo	-	-	5.3
	6.22	5.6	Sb	-	-	4.8
	7.81	5.5	Mi	-	-	4.7
	7.91	6.3	Lu	-	-	5.5
	8.08	5.8	De	-	-	3.1
	8.12	5.6	Co	-	-	4.9
	8.79	5.7	Vs	-	-	5.0
	8.89	6.2	Lu	-	-	5.5
	10.12	6.6	Co			5.9
	11.07	6.4	Co	0.108	-0.077	5.7
	11.17	6.0	Mo	-	-	5.3
	11.76	6.4	Vs	-	-	5.7
	12.05	6.4	Bo	-	-	5.7
	13.85	6.7	Vs	-	-	6.0
	15.96	5.0	Si	-	-	4.3
	17.90	9.0	Ha	-	-	5.9

Continued

TABLE 6

(Continued)

Average time of Observations	m_1	Observers	lg r	lg Δ	H_{10}
September 19.08	6.6	Ma	-	-	5.6
19.75	6.3	Vs	-	-	5.5
21.05	6.3	Co	0.084	-0.011	5.2
21.11	6.0	Mi	-	-	5.8
21.78	6.6	Vs	-	-	4.7
21.8	5.5	Wa	-	-	5.8
21.89	6.6	Lu	-	-	5.8
22.09	6.6	Co	-	-	5.9
22.80	6.7	Vs	-	-	4.7
22.82	5.5	Ha	-	-	5.7
22.89	6.5	Lu	-	-	5.5 /110
23.85	8.4	Bi	-	-	5.7
23.91	6.4	Lu	-	-	6.2
24.05	6.6	Co	-	-	5.7
24.71	7.1	Vs	-	-	5.9
25.07	6.6	Co	-	-	5.8
26.10	6.8	Mo	-	-	5.5
26.74	6.5	Vs	-	-	5.7
26.77	8.8	Bi	-	-	5.5
26.89	6.7	Lu	-	-	5.6 - 5.4
27.68	6.5	Chu	-	-	-
28.04	6.6;6.4	Mo, Co	-	-	-
28.60	7	Chu	-	-	6
28.80	8.8	Ba	-	-	5.1
29.89	6.1	Lu	-	-	-
29.30	flash	Ba	-	-	-
30.6	5.6	Chu	-	-	4.0 - 5.0
October 2.02	6.6	Co, Roe	0.074	-0.072	5.5
3.8	8.6	Bi	-	-	5.7
7.03	6.8	Co	-	-	5.7
8.7	8.8	Bi	-	-	6.9
10.12	6.9	Co	0.051	0.147	7.7
10.7	9.5	Bi	-	-	5.8
12.7	9.0	Bi	-	-	6.6
14.7	9.5	Bi	-	-	4.6
19.40	8.3	Se	-	-	4.4
20.40	8.5	Se	-	-	-
24.7	9.3	Bi	-	-	-
27.39	7.5	Se	-	-	-
29.39	8.4	Se	0.052	0.258	-
November 7.0	6.5	Bo	-	-	-
17.0	6.5	Zi	0.052	0.319	-

Continued

TABLE 6

(Continued)

Average time of Observations		m_1	Observers	lg r	lg Δ	H_{10}
December	26.84	8.5	Ur	0.0195	0.336	4.9
1971						
February	1.86	9.0	Bt	0.286	0.288	4.7
	3.65	8.5	J	-	-	4.2
	10.33	8.5 - 8.7	Bo	0.308	0.238	4.2 - 4.0
	26.38	8.9	Bo	-	-	4.6
	28.38	8.6	Bo	0.327	0.201	4.3
March	2.36	8.6	Bo	-	-	4.1
	22.16	8.9	Bo	0.326	0.246	3.9
	24.16	9.0	Bo	-	-	3.9
	24.17	9.3	Bo	-	-	4.1

The values of D_1 were: July 12.28 — 7'.0; September 7.91 — 4'; September 21.05 — 5'; September 26.74 — 5'; and October 2.02 — 13'.5.

The values of S were: September 21.05 — 0.032; September 26.74 — 0.042; and September 29.30 — 0.180.

In September, the comet reached 5^m (Mile, Waterfield, and Roemer), and was actively observed both in Europe and in America. It flared up by $0^m.5$ — $0^m.8$ near September 6 — 8 and at the end of September (26 — 31, Bakharev, Vsekhsvyatskiy, and others). The expedition of the Astronomy Faculty of Kiev University (Churyumov and Afanas'ev) used a 3-degree prism on the 50-cm telescope of the Alma-Ata observatory on September 2.7 to isolate C_2 emission; the comet was estimated to have D = 3 — 5', C = 1°.5 — 2°.0 with $m = 6^m.5$; on September 28.6, they observed CN in emission, and D = 2', C = 30'.

From September 30 through October 9, tens of photographs of the comet were taken at the mountain station at Zailiyskiy Alatau with a Schmidt camera (17/17 cm) (Churyumov). The comet had a brightness of 5 — 6^m and a tail 7° in length on the photographs. Seven spectra of the comet were obtained at Kamenskoe Plato with a spectrograph mounted on an AZT-8 telescope (Afanas'ev); the emissions of CN 3883, CH, C_3, C_2 (2.0), and (1.0) were resolved, and several faint emissions in the red spectral region were visible; a strong continuous spectrum was present.

In September — October, dropping southward, the comet /111
passed through Hercules; from the end of October, it crossed the head of Serpens and in December — January, it shifted into Libra. On November 5, Roemer noticed a pronounced but non-stellar condensation of $14^m.5$ on a photograph taken with the Steward reflector; the nucleus was 10" and surrounded by a coma with d = 1'; there were faint traces of several tail streamers. Near October 27, as Seki's estimate (see Table 6) shows, the comet flared up from $8^m.5$ to $7^m.5$; a strong outburst was repeated on about November 7, and again on November 17.0, Zinger estimated m = $6^m.5$. On December 22.8, T. Urata gave m_1 = $8^m.5$.

In February and March of 1971, the comet slowly faded, undergoing brightness oscillations within the range $8^m.5$ — $9^m.3$. It was observed for the last time on May 27, 1971.

Literature. IC, Nos. 2260 — 2270, 2272, 2275, 2279, 2281, 2285, 2289, 2290, 2292, 2300, 2308, 2310, 2311, 2315, 2317, and 2324; KTs, Nos. 105 — 115, 117 — 119; PASP, Nos. 489 — 492; Sky and Telescope, Vol. 40, No. 4; and ALPO Bulletins.

The initial orbit (IC, No. 2263) was determined by M. Candy (T = October 24.7, q = 1.17 a.u., and i = 123°.5); the following system was calculated by Marsden on the basis of an 11-day arc (IC, No. 2267, T = October 20.9, q = 1.116 a.u.). Sekanina's orbit (IC, No. 2270) was very similar to Marsden's initial orbit. New elements were calculated by Marsden on the basis of 70 observations between July 5 and October 6 (IC, No. 2281); T = October 20.7005, 1970, q = 1.112511 a.u., and i = 126°.714.

The initial values for H_{10} were: $4^m.1$ (Vsekhsvyatskiy, KTs, No. 105) and $5^m.6$ (Marsden). Marsden's photometric parameters were: $H_{10} = 4^m.0$; y = 15, and $h = 12^m.0$.

On the basis of the summary of photometric estimates, we obtain $H_{10} = 5^m.23 \pm 0^m.01$ and h_{10} (nucleus according to Roemer) = $13^m.5$. The photometric parameters were calculated by Bortle on the basis of his 28 estimates from August 3 through October 28: $H_y = 5^m.8$, y = 6.7; Morris obtained $H_y = 5^m.8$, y = 6.8 from an average based on the ALPO summaries (Milan), which differ significantly from Marsden's data (ALPO Bulletin).

D_1 = 5 — 7', and S = 0.180 a.u. (according to the observations of Churyumova with the 17/17 cm Schmidt camera; Kts, No. 109). See KTs, No. 108, concerning the comet spectrum.

r and Δ: July 3, 1970 — 2.00, 2.18; August 2 — 1.67, 1.43; September 3 — 1.35, 0.81; September 21 — 1.21, 0.98; October 11 — 1.12, 1.40; October 31 — 1.13, 1.81; November 20 — 1.22, 2.09; December 10 — 1.37, 2.20; December 30 — 1.57, 2.16; January 29, 1971 — 1.90, 1.90; February 28 — 2.23, 1.62; March 30 — 2.59, 1.63; and April 29 — 2.93, 2.15.